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WESTERN AUSTRALIA

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**COVER PICTURE**

**The old Department of Agriculture building in St. George's Terrace. Building commenced in 1832 as the first home of the Legislative Council. It still bears above the entrance the crest of the Lion and the Unicorn**

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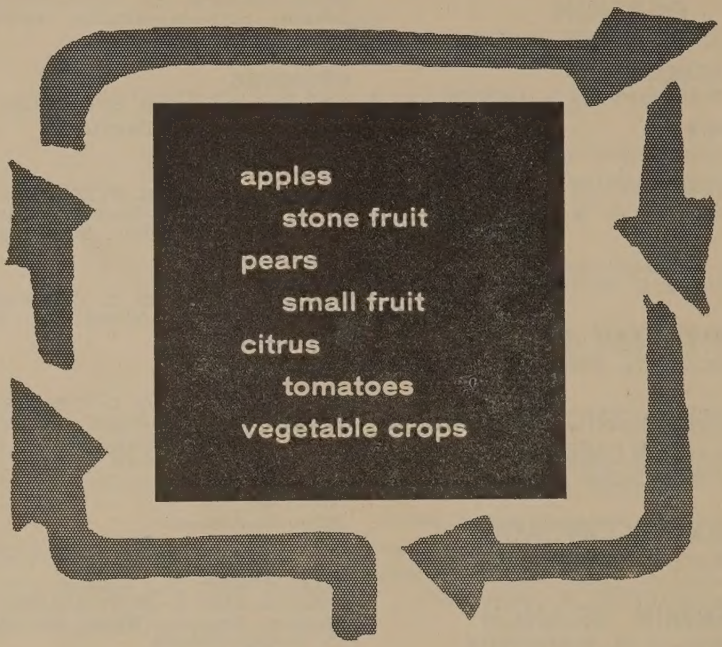


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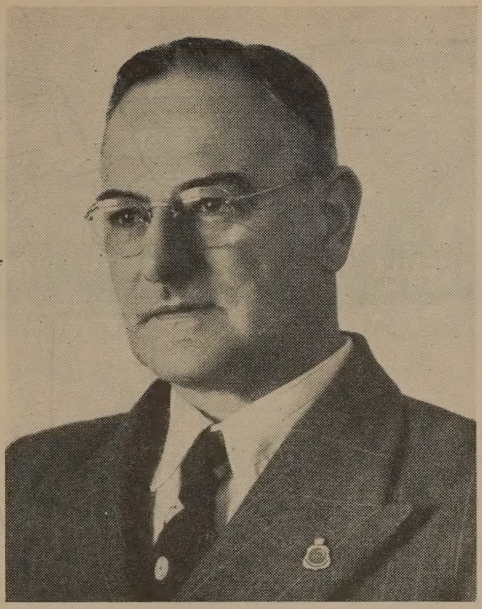
# Director of Agriculture Retires



Mr. George Kingston Baron Hay, M.C., B.Sc. (Agric.), Director of Agriculture of Western Australia since 1951, retired on September 2, bringing to a close a brilliant career in the Department of Agriculture which commenced 38 years ago.

The son of a Methodist minister, Mr. Baron Hay was born in Kingston, Jamaica in 1895. He was educated in England and at the age of 18, landed at Albany, Western Australia, and became a pupil at the Narrogin Farm school.

In 1915 he was one of the only two students enrolled at the Faculty of Agriculture in the University of Western Australia which then occupied premises in Irwin Street. Later in the year his studies were interrupted when he enlisted in the 51st Battalion, A.I.F.

He gained commissioned rank and was awarded the Military Cross in France in 1917, retiring at the conclusion of hostilities with the rank of lieutenant.

After graduating as Bachelor of Science (Agric.), he joined the Department of Agriculture in 1922 and served as an Agricultural Adviser for seven years, at first in the wheat and sheep and then in the dairying areas.

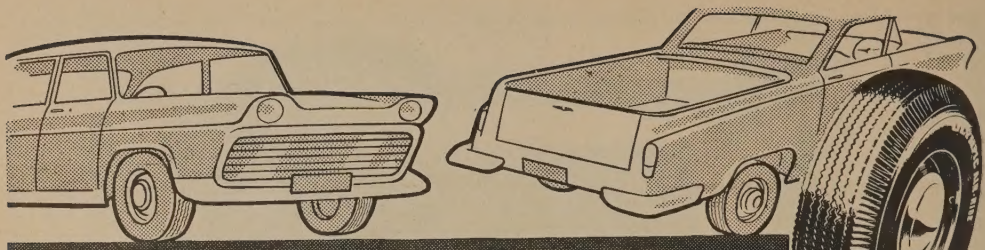
He became Superintendent of Dairying in 1930 and was promoted to Under-Secretary for Agriculture in 1941. In 1948 he was seconded to the Chairmanship of the Land Settlement Board and in 1951 he became Director of Agriculture.

Mr. Baron Hay was Australian delegate to the United Nations Food and Agriculture Organisation at Geneva in 1947, and is a past-president of the West Australian Institute of Agricultural Science. He represented the State on the Standing Committee on Agriculture for 20 years and was chairman or member of nine other committees dealing with agriculture or agricultural products where his practical outlook was of great value.

He travelled extensively throughout the State to gain first hand appreciation of the problems affecting agriculture and the best way the Department could assist.

It was while he was Under-Secretary and Director that the change from exploitation, to building up of the soil was stressed by the passing of the Soil Conservation Acts and the extension of ley farming. He realised the economy of the State depended on primary production but that the business of marketing, handling and processing played an important role in the final return to the State and the producer. Because of this he encouraged agriculturalists and marketing interests to join together on committees for promotion, research and orderly marketing.

He married Dr. Vera Cook, M.B., B.S. (Melb.), and has two sons one of whom has studied engineering and the other medicine.



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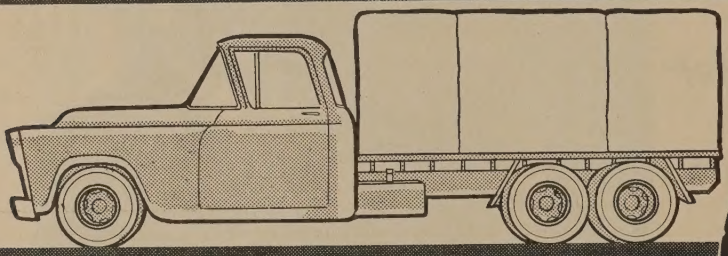

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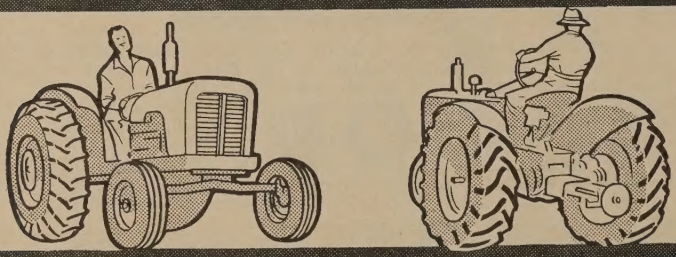

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# The Development

OF

# WESTERN AUSTRALIAN SAND PLAIN SOILS FOR AGRICULTURE

By R. P. ROBERTS, M.Sc. (Agric.), and F. L. SHIER, B.Sc. (Agric.)

## INTRODUCTION

**IN a recently published economic survey of the Australian wheat growing industry, it was reported that nearly two-thirds of the farms surveyed in Western Australia were located on lateritic "sand plain." As a random selection was made of the eighty farms that were visited it is reasonable to conclude that a similar proportion of all the State's wheat producing farms are on that type of country. This constitutes a remarkable change from the earlier days of wheat belt settlement when the sand plain soils were regarded as virtually useless and by-passed for development. It is the purpose of this article to give a brief account of the agricultural development of those soils in the south-western part of Western Australia and to consider the factors which have been responsible for the change.**

## WHAT IS LIGHT LAND?

In 1921 a conference was arranged in Perth to discuss methods for utilising the large tracts of light land which existed intermingled with the better quality heavier soils on which agricultural development had so far been concentrated. Most of this country lay to the east of the 18 in. isohyet and its low fertility did not constitute a problem until wheat belt settlement began to extend into the lower rainfall regions in the early 1900's.

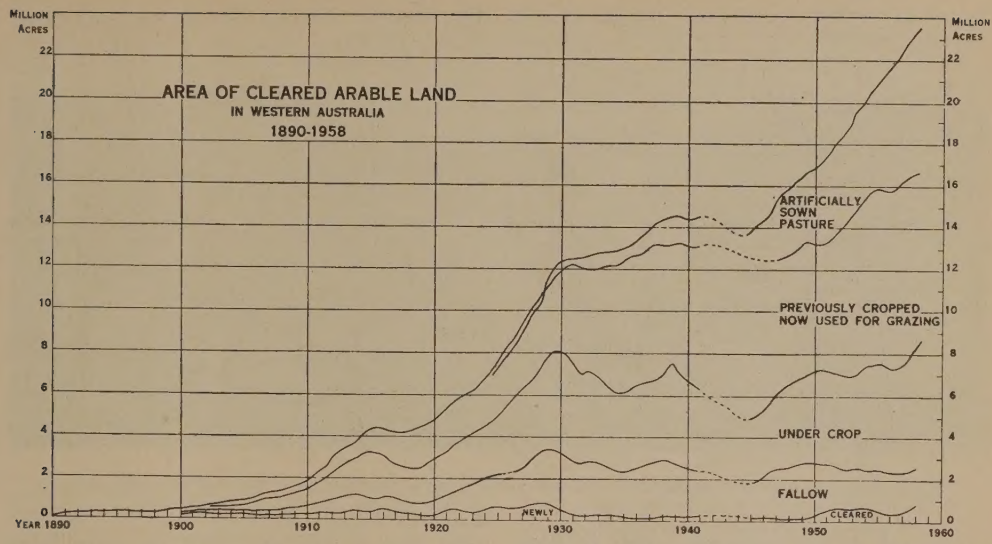
It was pointed out at the conference that the heavier soils "were characterised by forest growth, and our sandy lands by the growth of scrub rather than trees. The term light land has been broadly applied to all those lands which in their natural state did not produce trees—in effect, the treeless lands. These include sand plain, scrub plain and thicket lands, which range from a poor white sand to a light coloured loam of fine quality. The sandy soils vary in depth from a few inches to many feet, and generally overlie a gravelly or clay subsoil." It was estimated that up till then about 8 million acres of that type of country had been alienated, much of it adjacent to existing railways. Any method of increasing its productivity would be of considerable economic value.

The low fertility of much of the sand plain in its virgin state has often excited comment. In 1931, for example, Prescott noted that some of these soils did not respond to normal fertiliser treatment. Another authority described them in the following terms:—

> The natural poverty is most acute in Western Australia, where the south western corner is one of the most remarkable areas of poor soil in the temperate zones of the world.

In 1938 a Select Committee enquired into the light land problem. It estimated that at that time there were some 12 million acres of light land within 25 miles of existing railways. However, the Committee adopted a rather wider definition of light land than that given at the 1921 conference and included sandy and gravelly soils which carried a cover of trees of varying density. Also, it did not make clear whether the Committee's estimate referred to all undeveloped light land or only to that which was not alienated.

Example of land classification in Western Australia, south of Southern Cross, based principally on native vegetation. First class country is marginally shaded; second class country, principally carrying mallee, is indicated in black; while sand plain, or third class country, is left white. The map illustrates how the sand plain soils, the remains of the lateritic gravel capping which once covered the country, are intermixed with the better quality soils formed on the parent rock after erosion of the laterite. Scale, 1 in. = 1 mile. (From Prescott: The Soils of Australia in Relation to Climate and Vegetation.)

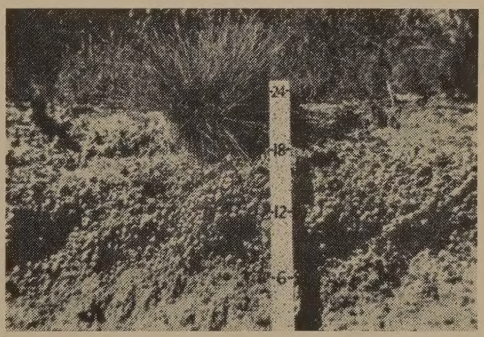



The area of cleared land has risen rapidly in the past 15 years. It is now more than 24 million acres compared with only about 14 million in 1945

As used at present the terms "sand plain" and "scrub plain" approximate closely to the definition of light land given at the 1921 conference. Soils of similar texture but carrying trees rather than scrub are an additional inclusion in the term "light land." Examples of the latter type are soils carrying white gum, banksia, jarrah and casuarina. This discussion is mainly concerned with former type, i.e., the sand plain.

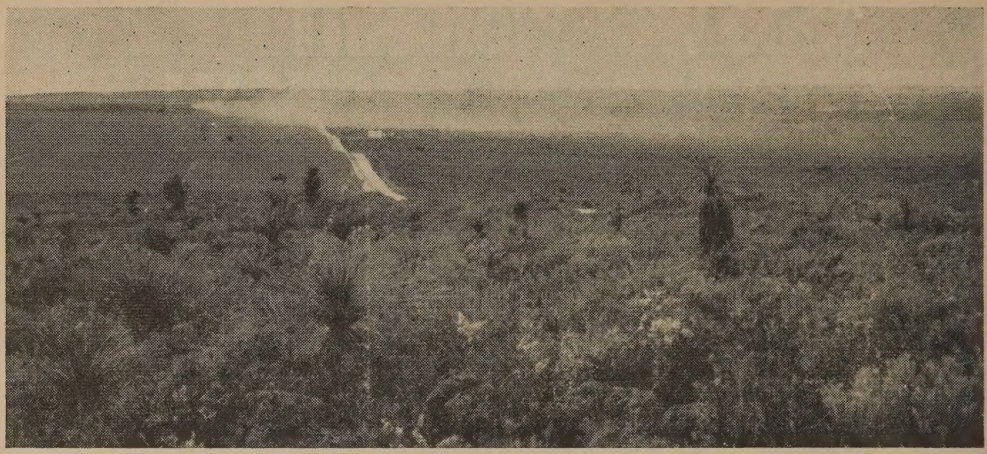
## THE AGRICULTURAL VALUE OF SAND PLAIN SOILS

Farmers' experiences with sand plain utilisation were described at the 1921 conference. Some had been fairly successful but others had failed. The usual experience was that it would produce a profitable crop in the first or second year but, under ordinary pioneering methods, yields would decrease in succeeding years and the land would soon fail to respond to an application of superphosphate. The deficiencies of the soil in regard to both nitrogen and phosphorus were clearly recognised, as was the consequent need for growing crops for grazing and making wheat growing subsidiary to stock production. The need for a light lands experiment farm was voiced by some of the speakers. An outcome of the conference was the establishment in 1924* of the Department of Agriculture's experiment farm at Wongan Hills in a 14-inch rainfall district. Meanwhile settlement extended farther into the lower rainfall districts and by 1930 most of the forest country in the farming districts has been alienated. Any further large scale progress depended on the more effective




Grey sand overlying gravel is a common profile on sand plain. The better types have some clay in the sub-soil. Where the soil is a leached white sand, and there is no evidence of clay within two feet of the surface, the land may not be worth the cost of developing

* Other sand plain research stations were established at Esperance (1949), Newdegate (1955), Badgingarra (1959).



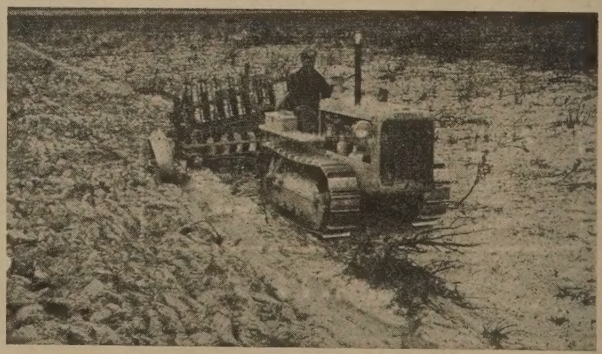
Sand plain country at Badgingarra about 100 miles north of Perth is being brought into production

utilisation of the extensive areas of light land, so much of which lay in the already settled areas.

## EXPERIENCE AT WONGAN HILLS

The advent of subterranean clover in the early 1920's gave the first promise of worthwhile progress in sand plain utilisation. However, clover was not the immediate success in the wheat belt that it had been in the higher rainfall districts of the south-west. This was illustrated by experience at Wongan Hills Research Station, where successful establishment of the early maturing subterranean clover variety Dwalganup, was achieved only after several years of disappointing results. The first experimental sowings were made there in 1935 and it was not until 10 years later that the problems of establishment were surmounted. By that time it was apparent that despite liberal superphosphate applications, both crop production and stock carrying capacity were declining under a four course rotation of bare fallow, cereal crop and two years of volunteer pasture. Soil erosion by both wind and water was clearly evident.

In 1946 a major pasture improvement programme was commenced on the Wongan Hills Research Station. This programme was based on Dwalganup subterranean clover and over the next 10 years the whole of the station was progressively sown with that plant. A ley system of farming without fallow was started in



The importance of eliminating as much as possible of the scrub residues before sowing pasture seed cannot be overemphasised. This is usually best achieved by rolling and burning the scrub, ploughing and leaving as bare fallow for eight to nine months

1951. Since then cereal yields have increased by 50 per cent. In the pre-clover era wheat crops averaged 14.2 bushels per acre; under the clover ley system yields have risen to 22 bushels. Sheep production has doubled from about 1 sheep to 3 acres to 2 sheep to 3 acres.

When new sand plain country is seeded for the first time it produces nothing without superphosphate. Heavy dressings of that fertiliser are necessary in the early stages of development. Trace elements are often an additional requirement

Similar results to these were being achieved by farmers on the sandy surfaced jam and York gum soils of the 16 in.-20 in. rainfall belt during the same period. The importance of the Wongan Hills work lay in the fact that subterranean clover was successfully established in a 14 in. rainfall, thus indicating the possibilities for improvement of several million acres of sand plain country with similar rainfall. The results obtained at this station provided a strong incentive and stimulus, on the technical side, to the large scale sand plain development which has occurred in the sheep and cereal districts since the war.

## IMPORTANCE OF OTHER FACTORS

Several other factors have stimulated interest in the development of these sandy soils.

One of major importance was recognition of the importance of trace elements, particularly copper and zinc. As a result, the productivity of much existing agricultural land was raised and profitable development of large areas of new country became possible. Since the war some 7 million acres, nearly a third of the State's cleared land, has been topdressed with one or both of these elements.

In some areas, notably in the north western part of the sheep and cereal districts, the blue lupin has been used with considerable success instead of clover as the pioneer legume.

Most of the sand plain soils which have been developed so far have a sandy surface

Heavy applications of superphosphate are required to establish subterranean clover on new sand plain country. The clover will persist only where soil phosphate reserves are adequate for its requirements. The plot on the right received dressings of 168 lb. per acre in each of the two previous seasons

Where the climate is suitable for subterranean clover, sand plain can be converted into good pasture country. In some areas where the rainfall is adequate, carrying capacity may exceed two sheep to the acre. Total expenditure required for the full development of a property may be in the vicinity of £20 per acre

and a subsoil containing some clay within two feet of the surface. Clover establishment in many cases has not always been so successful as on the better type soils, e.g., jam and York gum. Problems of phosphate needs, trace element deficiencies, soil micro-organism antagonism to rhizobial nodulation, inoculation technique and cultivation and seeding methods have required special study. Phosphate has been a major consideration and rates of application even reasonably approaching the requirement of subterranean clover for maximum growth are generally not possible with the financial resources of the average farmer. Over much of Western Australia this problem has been largely offset by the use of one or two cereal crops as cash crops prior to the introduction of the clover.

From the practical aspect the above procedure has several advantages. It enables some revenue returns in the developmental years which would not be the case if stock grazing was the initial intention; secondly, better seedbed preparation for the clover with the destruction of the harsh native vegetation is possible; thirdly, native poison plants can be largely eliminated by the additional cultivations and stubble burnings; finally, the phosphate status of the soil can be

An 80 bushel crop of Dale oats grown at the Esperance Plains Research Station. It was the first cereal crop on this land following six years of clover pasture

Lucerne on the Esperance Plains Research Station. Although lucerne was introduced into Western Australia in the early days of settlement it has never been of more than minor importance in the State's agriculture. However, recent work suggests that it may be valuable in districts along the south coast, where the growing season is longer than in the main sheep and cereal areas

improved through the residues remaining from fertiliser applied with the cereal crops and cultivation ensures a better distribution of the phosphate throughout the soil—a factor of some importance in clover establishment.

After several years under clover the productive capacity of much of the sand plain often approaches or even equals that of some of the soils of higher initial fertility. In addition sand plain is generally easier to work and underground water is usually found more readily.

This better understanding of the requirements for successful development of sand plain was achieved in time for the post war boom in prices for wool, and to a lesser extent for cereals, to exercise their

A heavy growth of lupins on sand plain country west of Mingenew. Sheep fatten readily on the large protein-rich dry seeds which they pick up from the ground after the plant has ripened and the seed shed

maximum effect. On account of income tax rebates it became very profitable for the recipients of large incomes to invest in the improvement of land for agriculture. As a consequence, apart from some six hundred thousand acres developed by the War Service Land Settlement Board, private operators have increased the area of cleared land in the State by more than 50 per cent. between 1945 and 1960, the total rising from 14 million to more than 24 million acres. It is not possible to estimate precisely how much of that total can be classified as sand plain in the terms of the definition given at the beginning of this article but it would probably approach 90 per cent. A considerable part of it, principally in the 11-13 in. rainfall belt has been developed without clover, mainly because the rainfall there is sub-marginal for the Dwalganup variety. However, for maximum production from those soils a legume is essential and the importance of finding one that will flourish in that environment is evident.

## THE FUTURE

Development of sand plain and other categories of light land will continue to occupy the attention of farmers in the wheat and cereal districts for some years to come. The productivity of considerable areas already cleared can be raised through the establishment of leguminous pastures, and there are several million acres more of similar untouched country in districts where the rainfall is sufficient for agriculture.

## MINISTER VISITS THE KIMBERLEYS

The Minister for Agriculture (Mr. C. D. Nalder, M.L.A.), recently returned from a visit to the Kimberleys which was undertaken to acquaint him with problems of that area. He said on return that beef production would continue to be of major importance in any foreseeable future.

General quality of the stock reflected the good season of 1959 followed by exceptional favourable rains this year. The Minister said he was fortunate in witnessing large mobs of cattle being driven to Wyndham Meatworks over distances up to 250 miles. Good roads were the greatest immediate need in the opinion of Mr. Nalder. He said road transport was being used in the West Kimberley and by comparison with the driven cattle there was not the same loss of quality or weight, and in addition stock were being turned over at a younger age.

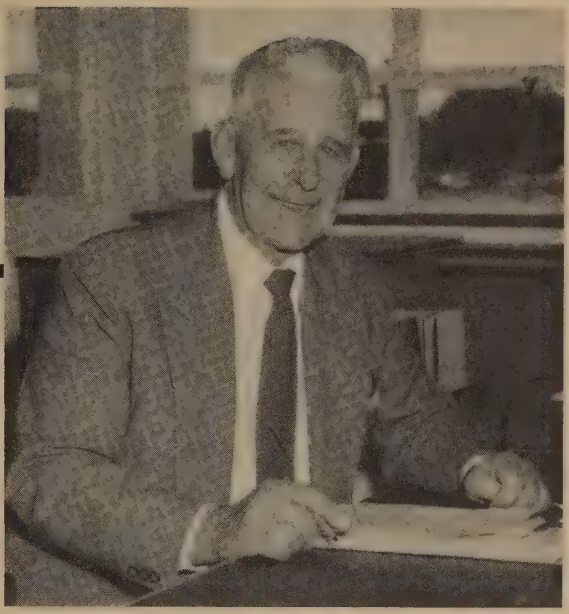
Mr. Nalder said that in common with the Murchison and Gascoyne districts there was a basic need for pastures of a more permanent nature to enable a greater turnover of stock. Fortunately, pastoralists were recognising this and following methods demonstrated by trials and experiments conducted in collaboration with officers of the Department of Agriculture. There was a keen interest in pasture renovation and management, by the practice of distributing seeds of such plants as buffel and Birdwood grasses and kapok bush. The necessity and economics of sub-division are being freely discussed and appraised.

Mr. Nalder said the Kimberley Research Station was very impressive, especially the work now being done for the practical establishment of those crops which research has shown can be grown in the area. A special study was being made of the economic production of cotton, which could become a major crop in any closer settlement scheme. Two experiments of particular interest were economic insect control and the testing of varieties suitable for mechanical harvesting. Yields and quality are already known to be satisfactory.

The Minister said a successful rice crop at Camballan appears to be assured but he was particularly impressed by a crop of Sudan grass which had already been cut for hay with prospects for at least two more cuts for this season. The production of such fodder offers an important advancement to the pastoral industry, he said.

The Minister, who was accompanied by the Director of Agriculture (Mr. G. K. Baron Hay) and the Agricultural Adviser for the district (Mr. K. Fitzgerald), expressed appreciation for the assistance given by local authorities and pastoralists to make the trip possible and for the ready way in which advice was given and records were made available.

# Our Late Editor



OBITUARY

Shortly before this issue of the Journal went to press, the Department of Agriculture suffered a severe loss in the passing of the Editor, Mr. J. A. Mallett, whose death occurred on September 24.

At the age of 17 he enlisted in the British Regular Army and served with distinction in World War I in France, Belgium, Salonika, Rumania, Bulgaria, Egypt and Palestine. At the end of the war he held the rank of Captain and had won the Military Medal.

He migrated to Australia in 1922 and took up a 1,400 acre property at Lake Biddy, later moving to North Nippering. While working his property he began free lance writing under the pen name of "Martingale" and his flair for the written word assisted many farmers to bring their disabilities under the notice of the Governments. He joined the staff of The Western Mail in 1935 and his mutual help pages became an expression of his practical way of looking at problems of the man on the land.

In October 1951, after 16 years as agricultural editor of The Western Mail, he joined the Department of Agriculture as Editor of "The Journal of Agriculture," and Publicity Officer. At that time the Journal was a quarterly. Under his direction it rose to six copies a year, and this year he realised his ambition in making it a monthly periodical. During these years he made radical changes in its style, always aiming for what he called "readability."

His interests were varied but nearly all were directed to assisting the farmer and his wife. He broadcasted over the A.B.C., his subjects ranging from farm activities to book reviews. He was a judge or commentator of sheep dog trials and for years he commented over the p.a. system at the Royal Show on the Grand Parade and the sheep dog trials there. He rose to the presidency of Perth Legacy and of the W.A. Guide Dogs for the Blind Association.

He leaves a wife and two children.

# *Brucellosis*

# Can cause Contagious Abortion in Cattle and Undulant Fever in Man

By F. WILKINSON, B.V.Sc., Veterinary Surgeon

**WHEN the cow, shown in the accompanying photograph, was purchased it had a small fluid-filled lump on the left knee. The swelling did not appear to be painful but gradually increased in size until it assumed the proportions shown in the picture. It was a typical case of "big-knee," one of the less common manifestations of Brucellosis—the disease commonly known as contagious abortion—and a blood test of the animal confirmed the diagnosis.**

The introduction of this Brucellosis-infected cow into his herd was a serious matter for the owner. Several other cows in the herd became infected and aborted their calves. This caused a serious drop in milk production and he had to purchase more cows in milk to maintain his quota supplies. Affected cows proved difficult to get into calf again.

Cows usually become infected through eating pasture contaminated with Brucellosis organisms. An infected cow, such as that pictured, passes out vast numbers of Brucellosis germs in the afterbirth at calving and in the discharges after calving. Even the dung and urine may carry the germs.

When a "clean" cow picks up the infection by eating the germ-laden pasture the germs tend to localise in the udder, in the uterus or womb if the animal is pregnant, or in the glands or joints.

In the case of a pregnant cow, the germs become concentrated in the unborn calf and the membranes which surround it, usually leading to the death of the foetus and it explusion so that the cow aborts or "slips its calf." This usually occurs about three months before the expected calving date.

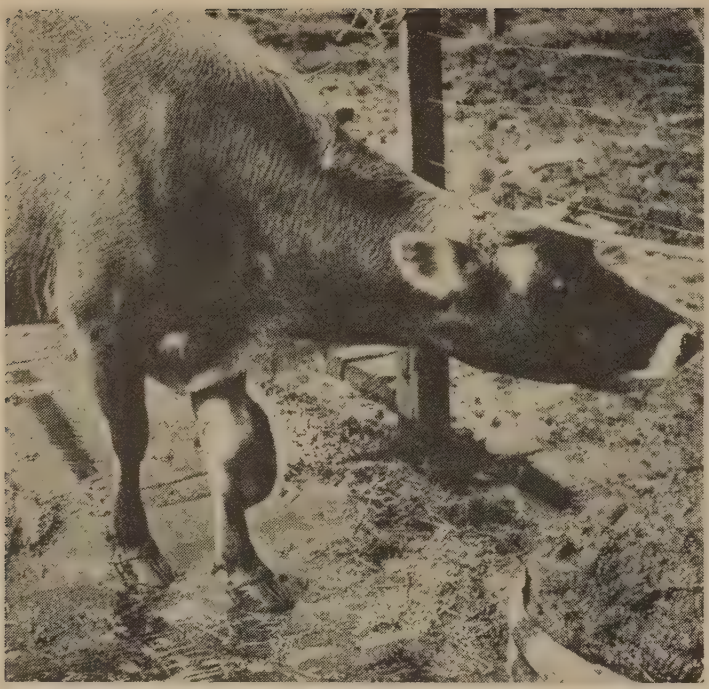
After aborting, the cows often fail to clean properly. Retained afterbirth is a common trouble, and often there are secondary infections which result in offensive discharges continuing for some weeks. There is usually difficulty in getting such cows into calf again.

The initial introduction of Brucella infection into a "clean" herd can lead to a costly "abortion storm" which involves heavy losses in calves and milk production and a high incidence of temporary infertility.

Infected cows tend to build up an immunity and seldom abort a second time, but they remain carriers of the disease and can readily infect any "clean" animals in the herd.

Although there is no cure for the disease, once it gains a footing in the herd, it is possible to protect the "clean" animals—particularly the young heifers—by vaccination with Strain 19 vaccine. Vaccination of all heifers before they mature—usually between six and nine months of age—will, in most cases give a lifetime immunity.

The Department of Agriculture undertakes the vaccination of heifers throughout the dairying areas and is prepared to



Note the large swelling on the knee of this cow. It is the result of Brucellosis infection, and the animal is a "carrier" and a danger to uninfected animals

make officers available to carry out the work. A fee of 2s. per head is charged for all cattle vaccinated in order to defray the cost of the vaccines used.

## DANGER TO HUMAN HEALTH

For many years, the British garrisons in the island of Malta were subject to a form of fever in which the temperatures of the patients fluctuated greatly and they suffered severe pains and swellings. The cause was eventually traced to a Brucella infection in the goats which were the main source of the island's milk supply.

Although this particular organism, *Brucella melitensis,* is not known to be present in Australia, there have been a number of cases of the so-called "undulant fever" resulting from infection of human beings with *Brucella abortus,* the organism which causes Brucellosis or contagious abortion in cattle.

Unless it is boiled or pasteurised, milk containing Brucellosis germs can infect humans with this painful disease which is a serious menace to health as it does not respond readily to treatment and the infection endures for several weeks or even months.

The infection may be contracted directly from infected material such as afterbirths and discharges from aborted cows. Workers handling such animals should use disinfectants freely.

Brucellosis is a serious disease and if it is suspected in your herd, you should seek veterinary advice immediately.

Fig. 1—This photograph shows the massive growth of well-developed banana stools

# Water Usage Trials with Bananas on the Gascoyne

By W. M. NUNN, B.Sc. (Agric.), Officer-in-Charge, North-West Branch.

**THE banana industry at Carnarvon is an unusual one by most agricultural standards. Normally a tropical plant liking relatively humid conditions in a high rainfall, the banana is cultivated at Carnarvon in an area of extremely low rainfall and with relatively low humidity throughout the year. Water is pumped to irrigate the crop from the sands of the Gascoyne River bed or from bores adjacent to the river course.**

Since most of the soils are free-draining, sandy loams, and the banana a fast-growing plant of considerable bulk and water content, it is to be expected that water usage would be higher than for most agricultural crops.

Unfortunately the Gascoyne settlement water supplies are somewhat insecure and dependent upon rain falling over a distant inland catchment area in pastoral regions of low rainfall.

So-called "first-water" or "top-sand" reserves are tapped at depth of 10 to 20 ft. and, unless the river flows with regularity, can be very quickly exhausted.

Additional supplies have been obtained in dry periods, by drilling to depths of up to 60 ft., when "second water" rises in the bore to augment the failing top reserves.

Recent exploratory work carried out by Public Works Department has shown that these second waters cannot be relied on to provide any lasting improvement, and that hope for augmenting supplies lies rather in piping water from a few miles higher up the river where "top reserves" are held back by a natural clay barrier.

If this proposal is implemented some considerable improvement can be expected. The plan however, calls for extensive Government planning and expenditure and must take some years to achieve.

In the meantime the district has voted in favour of a scheme to provide some

Fig. 2—A young plantation at the developmental stage. Much of the ground surface is still exposed and at this stage the water requirement is at a high level

control over the use of water, and a Committee consisting of grower and Government representatives meets regularly to advise the Minister for Works and Water Supplies. Meters have been provided and a water usage rate determined for several of the larger growers, and since it is impossible for the present to obtain and fit meters all round, the remaining growers are controlled on a restricted acreage basis. Quantities and acreages will be varied by the committee according to season and river reserves.

This represents some very real progress toward safe-guarding the industry against recurring water shortages, but the old question arises—Should bananas really use as much water as they do under existing methods?

In determining a rate of application in order to correlate acreages and water rates for the present control schedules, district methods were assessed as averaging a water application of 1 ft. per month, or 12 ft. per year. This is a moderate estimate based on efficient working with good channel control, and we know that there are growers who use considerably more than this.

Fig. 3—Third-year bunches being removed from the Fertiliser Trial plots at the Gascoyne Research Station, in 1955. This plantation is still thriving despite enforced reductions in water usage during recent dry seasons

Fig. 4—Sprinklers in action on a Lucerne Irrigation Trial at the Gascoyne Research Station. A section of the Banana Water Usage Trial, reported in this article, may be seen in the background

Making due allowance for rainfall differences it can be said that bananas at Carnarvon use at least half as much again, and possibly twice as much water as is used on such crops as lucerne in other irrigation areas.

With the very dry climate, the freely draining soils and the prolific growth of the banana stool, this may not be surprising or unexpected but it does occasion the thought—"Can we help the present situation by devising methods of economising on water applications?"

The possible use of sprinkler irrigation immediately suggests itself as a water saver, but sprinklers have been tried without success on a number of occasions. In actual trials on the Gascoyne Research Station, with sprinklers mounted both above and below the canopy, the result was the same—"raindrop splash" caused a sealing of the surface soil, preventing penetration and causing water to run off and accumulate in low spots.

In a trial commenced in 1954 and continued over four years, several different rates of flooding were compared with the intervals between watering rates previously used. Another section of the trial applied the standard 4 in. watering at varying intervals.

In both sections it was shown that reduction of water below the customary application delayed early development, but that once the canopy stage was attained the initially retarded plots rapidly caught up and produced as well as any.

During the period of dwindling water supplies in 1959 a number of growers took their cue from these experiments and either reduced applications, or lengthened intervals on developed plantations, with quite successful results.

With the detail now being collected in connection with the water control operations a much more accurate assessment of water use and water requirement should be possible. On present information it would seem that many growers could halve their water usage once the plantation is in production, without detriment to yield.

There remains the problem of high requirement during early stages, and this is the subject of a study recently commenced with experimental plots established on the property of Mr. W. Smales, on the lighter soils of the north side of the river.

Three different planting systems are compared—two watered by different furrow systems and one by flooding of bay, but with a surface cover of polythene film.

A series of decreasing frequencies of watering is superimposed on the three planting systems.

Similar trials are planned for vegetable crops during the 1960 season, and it is hoped that before long we may have accumulated reliable data to aid the planter in his effort to make best use of limited water supplies, and the River Advisory Committee in its effort to devise a rational basis for control of water distribution.

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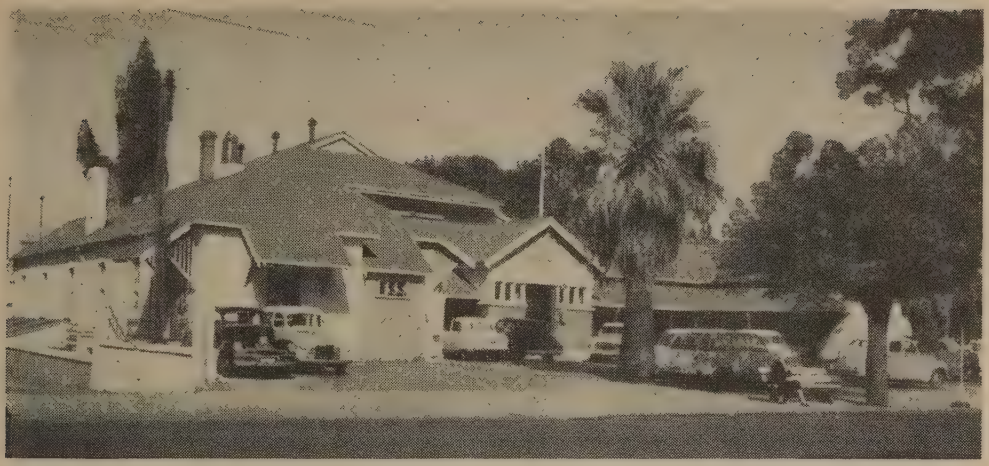

Fig. 1.—The old building

# *Department of Agriculture*
# MOVED TO SOUTH PERTH

**AFTER more than half a century in the historic but time-worn building, one of the few adorned with the British Government crest of the Lion and Unicorn, on the eastern side of the Government Gardens in St. George's Terrace, the Department of Agriculture has been transferred to a new location in South Perth.**

The old building—soon to be demolished to make way for a new Town Hall—was commenced in 1836 and was designed by the Government Architect of that time, Mr. Henry W. Reveley who designed the Round House at Fremantle.

It is on record that the Swan River Colony's first Legislative Council met on the site in 1832—probably in tents or huts—and after its completion continued to meet in the building until 1870 when it moved to a building which formerly stood on the site of the new Rural and Industries Bank premises now nearing completion.

The colony's post office was housed in the old building from 1840 to 1853 and again from 1857 to 1867, and the Colonial Secretary had an office there until 1876. In 1890, the Legislative Council returned to the site and continued to meet there until 1904 when it moved to Harvest Terrace and handed over the building to the Department of Agriculture.

The fore-runner to the Department of Agriculture was the Bureau of Agriculture inaugurated in 1894 with headquarters at Weld Chambers in St. George's Terrace. The Bureau was later moved to West Australian Chambers and in 1898 it was reconstituted as the Department of Agriculture at that address.

During the first half of the present century there was a tremendous expansion of agricultural activity in Western Australia with a corresponding growth of the Department.

The old building soon proved inadequate to house the new branches and divisions which came into being. Staff figures were 229 in 1928 against 742 now, and—prior to

Fig. 2.—One of the new sections

Fig. 3.—A view of two of the blocks showing the ground level and upper floor connecting ways

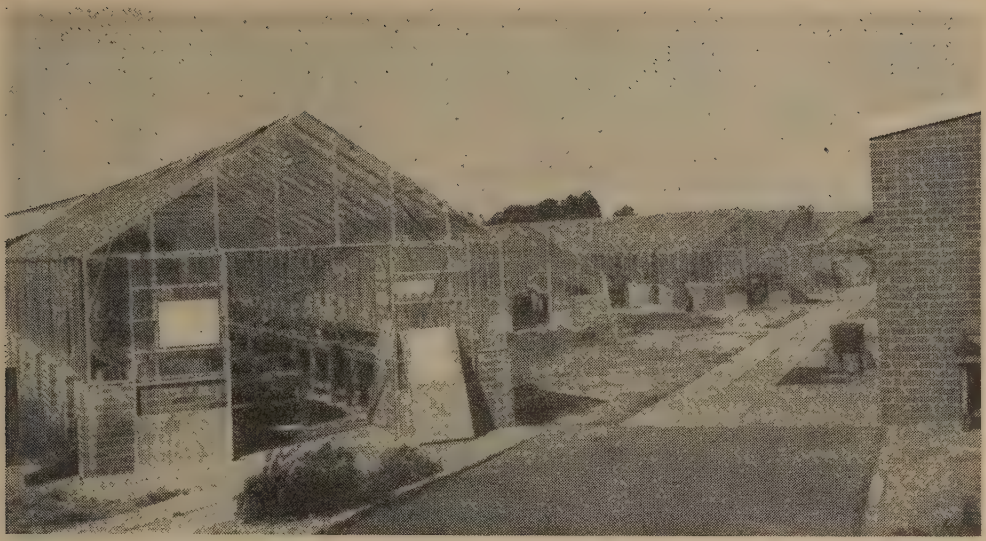

Fig. 4.—A view of the glasshouses

the erection of the new buildings at South Perth—units of the Department of Agriculture were also located in the Observatory buildings, at the old Orphanage in Adelaide Terrace, in the Treasury Buildings and at the Animal Health and Nutrition Laboratories, Hollywood.

Much of the accommodation was substandard and of a makeshift nature which, together with the widespread dispersal of the units, created a number of administrative problems, yet some of the Department's most creative efforts were made under those conditions.

## THE NEW BUILDINGS

The new buildings are the culmination of about fifteen years' striving for a site and the necessary finance. Other sites discussed were just east of Herdsman's Lake, and a St. George's Terrace site alongside Christian Brothers' College.

A 33-acre site in a cleared section of the Collier Pine Plantation was reserved for the Department in South Perth. It is in the northern corner of the plantation, bounded on the north-east by Jarrah Road and on the north-west by George Street. The site is easily reached from all main country highways without entering the city.

The foundation stone for the first block of buildings was laid by the then Minister for Agriculture (the Hon. E. K. Hoar, M.L.A.), on April 5, 1956.

The three main laboratory and office blocks are two-storey buildings of reinforced concrete construction. Columns, beams and flooring slabs were pre-cast on the site. The bays between the columns are in-filled with steel frames, windows, and half-inch thick abestos-cement panels.

Vermiculite concrete blocks are used internally to form an insulating dado wall from floor to window-sill height and acoustic tile panels are fixed between the steel roof members which support the five-degree corrugated asbestos roofing.

The blocks are 38 ft. wide internally divided by central corridors 5 ft. wide to leave 19 ft. on the south side for laboratories and approximately 13 ft. on the north side for offices. Each block has its axis running east and west giving north lighting for the offices and south lighting for the laboratories.

There are many unique features in construction some of which have been copied in scientific buildings elsewhere.

Flexibility is the keynote of the design and internal division is by 2 in. thick plaster partitions which are movable and

Fig. 5.—The enclosed hard standing for departmental vehicles

may be readily re-positioned at approximately 3 ft. 6 in. centres. Benches are in long runs to facilitate re-positioning of the partitions and movable cupboard and drawer units under the benches slide on runners and may be re-arranged as required.

All internal drainage from sinks is by acid-proof polythene plastic which may be cut and welded as required to suit any re-positioning.

Gas, electricity and hot and cold water services all run on brackets under the benches with take-offs at approximately 7 ft. intervals in skirtings above the benches.

All rooms are mechanically ventilated from a central installation and heated by black rod heaters built into the internal face of the vermiculite concrete wall.

Portable fire extinguishers throughout the blocks and fire hydrants in the grounds

Fig. 6.—The administrative block under construction

provide normal protection against fire, but separate automatic carbon dioxide installations are installed to guard irreplaceable botanical collections in the State Herbarium and the extensive collection of insects in the Entomological Branch.

Ancilliary buildings include two large stores' buildings, three modern animal houses, a series of glass-houses and service buildings, a caretaker's cottage, and a fully-enclosed hard standing of 11,000 square feet for Departmental vehicles. There are adequate parking facilities for staff and visitors.

Another large block to house the administrative sections and Accounts Branch of the Department is now under construction.

Local materials and local manufacture were used wherever possible.

All the technical branches and divisions of the Department of Agriculture are now established in the new buildings which were officially opened by the Premier (the Hon. David Brand), at 4 p.m. on August 26.

Fig. 7.—Unveiling a plaque at the official opening


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# REGISTERED FERTILISERS

THE FOLLOWING REGISTERED FERTILISERS AND ANALYSES ARE SUPPLEMENTARY TO THE LIST PUBLISHED IN THE APRIL 1960 ISSUE OF THE JOURNAL OF AGRICULTURE . . .

| Name of Fertiliser | Reg. No. | Registered Brand | By Whom Registered | Nitrogen (N) as | | | | Phosphoric Anhydride ($P_2O_5$) as | | | | Potash ($K_2O$) as | | Minor Elements | | | | | | | | Cash price per ton at Works (W) or on rail Perth (P) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Nitrate | Ammonia | Blood and Bone | Urea | Wat'r soluble | Citrate soluble | Acid soluble | Total soluble | Sulphate | Muriate | Cu | Zn | Co | Mn | Mg | Fe | Mo | B | AL | |
| A. MINERAL | | | | % | % | % | % | % | % | % | % | % | % | % | % | % | % | % | % | % | % | % | |
| **1a. Nitrogen as Nitrate** | | | | | | | | | | | | | | | | | | | | | | | |
| Calcium Ammonium Nitrate C.A.N. | 289 | Rhur-Stickstoff | Swift & Co. | 10·25 | 10·25 | 37·50 $CaCo_3$ | | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | £36 (P) |
| C.A.N. (Calcium Ammonium Nitrate) | 291 | Wesfarmers | Westralian Farmers Co-op. Ltd. | 10·25 | 10·25 | 37·50 $CaCo_3$ | | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | £36 (P) |
| **1c. Nitrogen as Urea** | | | | | | | | | | | | | | | | | | | | | | | |
| Urea .... .... | 286 | C.S.M.L. .... | Cuming Smith Mt. Lyell | .... | .... | .... | 46·00 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | £66 (W) |
| **4. Nitrogen and Phosphoric Anhydride** | | | | | | | | | | | | | | | | | | | | | | | |
| Lawn Manure .... | 284 | Dawn .... | Dawn Fertilisers | .... | 5·75 | .... | .... | 8·75 | 2·00 | 1·75 | 12·50 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | Packets |
| **5. Nitrogen, Phosphoric Anhydride and Potash** | | | | | | | | | | | | | | | | | | | | | | | |
| Rose Manure .... | 283 | do. .... | do. do. | .... | 5·25 | .... | .... | 7·75 | 1·25 | 2·00 | 11·00 | .... | 3·25 | .... | .... | .... | .... | .... | .... | .... | .... | .... | |
| Plant Food .... | 282 | do. .... | do. do. | .... | 5·39 | .... | .... | 7·85 | 1·15 | 2·00 | 11·00 | .... | 3·50 | .... | .... | .... | .... | .... | .... | .... | .... | .... | |
| Superhumus No. 1 .... | 281 | do. .... | do. do. | .... | 2·00 | .... | .... | 1·80 | 0·50 | 0·20 | 2·50 | .... | 2·00 | .... | .... | .... | .... | .... | .... | .... | .... | .... | |
| Superhumus No. 2 .... | 280 | do. .... | do. do. | .... | 4·00 | .... | .... | 3·00 | 0·50 | 6·50 | 10·00 | .... | 0·50 | .... | .... | .... | .... | .... | .... | .... | .... | .... | |
| **9. Nitrogen, Phosphoric Anhydride, Potash and Minor Elements** | | | | | | | | | | | | | | | | | | | | | | | |
| Greengro .... .... | 267 | Green Garden | Green Garden Products | .... | .... | .... | 2·75 | 5·00 | 1·00 | 1·00 | 7·00 | .... | 5·00 | Trace | Trace | .... | Trace | .... | .... | .... | .... | .... | Packets 4s. |
| Completed Pelletised Plant Food for Vegetables | 271 | Quik-gro .... | Creamoata Ltd..... | .... | <——7·06——> | | | 6·4 | 2·8 | 2·7 | 11·9 | <–2·99–> | | ppm 6 | ppm 3 | ppm 1 | ppm 40 | ppm 60 | ppm 45 | ppm 1 | ppm 7 | (Ca) 1·1 | 26s. doz. |
| Pelletised Plant Food for Roses | 272 | do. .... | do. do. .... | .... | <——9·46——> | | | 1·10 | 0·91 | 1·12 | 3·13 | <–3·00–> | | 6 | 3 | 1 | 40 | 60 | 45 | 1 | 7 | 1·1 | 26s. doz. |
| Complete Pelletised Plant Food for Pot and Indoor Plants | 273 | do. .... | do. do. .... | .... | <——4·16——> | | | 2·4 | 1·5 | 0·3 | 4·2 | <–2·00–> | | 6 | 3 | 1 | 40 | 60 | 45 | 1 | 7 | 1·1 | 26s. doz. |
| Lawn-gro, The Complete Lawn Food | 275 | do. .... | do. do. .... | .... | <——9·46——> | | | 1·10 | 0·91 | 1·12 | 3·13 | <–3·00–> | | 6 | 3 | 1 | 40 | 60 | 45 | 1 | 7 | 1·1 | 26s. doz. |
| The Complete Pelletised Plant Food for Flowers | 276 | do. .... | do. do. .... | .... | <——7·06——> | | | 6·1 | 2·2 | 2·5 | 10·8 | <–2·9—> | | 6 | 3 | 1 | 40 | 60 | 45 | 1 | 7 | 1·1 | 26s. doz. |
| The Complete Pelletised Plant Food for Shrubs and Fruit Trees | 277 | do. .... | do. do. .... | .... | <——7·06——> | | | 5·8 | 2·1 | 2·1 | 10·0 | .... | 3·00 | 6 | 3 | 1 | 40 | 60 | 45 | 1 | 7 | 1·1 | 26s. doz. |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rustica Complete 13 : 13 : 21 | 287 | Rhur-Stickstoff | Swift & Co. | 0·60 as Ammonium Nitrate<br>5·40 as Potassium Nitrate<br>1·60 as Mono/Diammonium Phosphate<br>5·40 as Ammonium Chloride | | 5·40 as Mono/Diammonium Phosphate<br>7·60 as Dicalcium Phosphate | | | | 19·10 as Potassium Nitrate<br>1·90 as Potassium Chloride | | ·002 to ·003 | ·011 to ·013 | .... | ·002 to ·003 | 0·21 | .... | ·0001 | 0·001 to 0·005 | .... | £53 18s. 6d. (W) (P) | | | | | | | |
| Rustica Complete 15 : 15 : 15 | 288 | do. | do. do. ... | 4·20 as Ammonium Nitrate<br>4·50 as Potassium Nitrate<br>1·90 as Mono/Diammonium Phosphate<br>4·50 as Ammonium Chloride | | 6·60 as Mono/Diammonium Phosphate<br>8·40 as Dicalcium Phosphate | | | | 15·00 as Potassium Nitrate | | 0·002 to 0·003 | 0·011 to 0·013 | ... | 0·002 to 0·003 | 0·31 | .... | ·0001 | 0·001 to 0·005 | .... | £60 18s. 6d. (P) | | | | | | | |
| Wesfarmers Complete Red | 290 | Wesfarmers | Westralian Farmers Co-op. Ltd. | 0·60 as Ammonium Nitrate<br>5·40 as Potassium Nitrate<br>1·60 as Mono/Diammonium Phosphate<br>5·40 as Ammonium Chloride | | 5·40 as Mono/Diammonium Phosphate<br>7·60 as Dicalcium Phosphate | | | | 19·10 as Potassium Nitrate<br>1·90 as Potassium Chloride | | ·002 to ·003 | ·011 to ·013 | .... | ·002 to ·003 | 0·21 | .... | ·0001 | ·001 to ·005 | .... | £53 18s. 6d (W) (P) | | | | | | | |
| **11. Trace Elements** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Comozin .... .... | 270 | Greengro | Barrow Linton .... | . | .... | . . | .... | .... | .... | .... | .... | .... | 4·6 | 6·4 | .... | .... | .... | .... | 0·23 | .... | .... | £54 10s. (W) (P) | | | | | | | |
| Traces . .... | 279 | Dawn .... | Dawn Fertilisers.... | .... | .... | . . | .... | .... | .... | .... | .... | .... | 0·90 | 0·20 | .... | 2·00 | 2·50 | 37·60 | 0·20 | 0·50 | .... | Packets | | | | | | | |
| | | | | Nitrogen (N) as | | | | Phosphoric Anhydride ($P_2O_5$) as | | | | Fine Material | | | | | | | | | | | | | | | | | | | |
| | | | | Nitrate | Ammonia | Blood and Bone | Urea | Wat'r Soluble | Citrate Soluble | Acid Soluble | Total | | | | | | | | | | | | | | | | | | | |
| | | | | % | % | % | % | % | % | % | % | % | | | | | | | | | | | | | | | | | | |
| B ORGANIC<br>**1. Blood and Bone** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Blood and Bone .... | 269 | Waruna .... | L. H. Rawling .... | .... | .... | 7·0 | .... | ·16 | 3·0 | 9·0 | 12·16 | a 100 b 55 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | £43 10s. (P) | | | | | | | |
| Blood and Bone .... | 285 | Dawn .... | Dawn Fertilisers .... | .... | .... | 5·0 | .... | .... | 2·00 | 8·00 | 10·00 | a 100 b 55 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | Packets | | | | | | | |
| **4. Fish Fertilisers** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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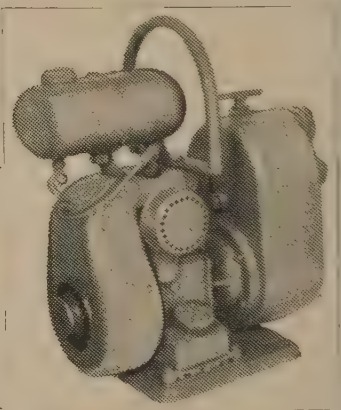

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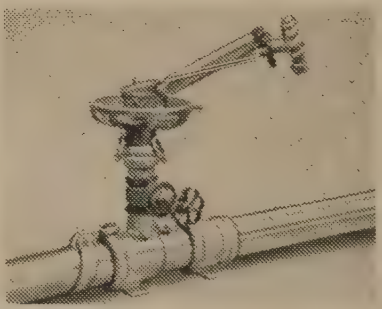

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## SOURSOB

*(Oxalis pes-caprae* L.*)*

Soursob is another introduction from South Africa and has become established in a number of districts, especially in the Avon Valley. Although the leaves have the appearance of a clover, Soursob is unpalatable and is not closely related to the clovers.

# WEEDS of Western Australia

By **G.R.W. MEADLY** M. Sc.
Officer in Charge, Weeds and Seeds Branch

## SOURSOB

### *(Oxalis pes-caprae* L.)

**DURING winter and spring, the yellow colouration of paddocks is not always due to the flowers of the widely distributed Capeweed. In some districts, particularly in the Avon Valley, the yellow-flowered soursob (Oxalis pes-caprae L.), has become firmly established. The genus Oxalis contains 800 or more different species, the two main natural centres of distribution being South Africa and tropical and extra-tropical South America.**

The two species native to Australia have been supplemented by a number from South Africa. The commonest of these is *O. pes-caprae,* to which the name "soursob" is most frequently applied. The other species include yellow, pink and red-flowered types, having a similar herbaceous perennial habit.

Soursob has its strongest development in South Australia where, in many parts, it dominates the landscape. It occurs extensively in Victoria, and also infests appreciable tracts of land in New South Wales and this State. Species of *Oxalis* were introduced to England as garden subjects as early as 1658, while about a century later other species were arriving from the Cape of Good Hope. There is little doubt that the common soursob found its way to this country as an intentionally-introduced garden bulb, and almost certainly was brought from the Cape Province. It appears to have been introduced prior to the establishment of the Adelaide Botanical Gardens in 1855 and was recorded in the first catalogue of cultivated plants issued in 1859.

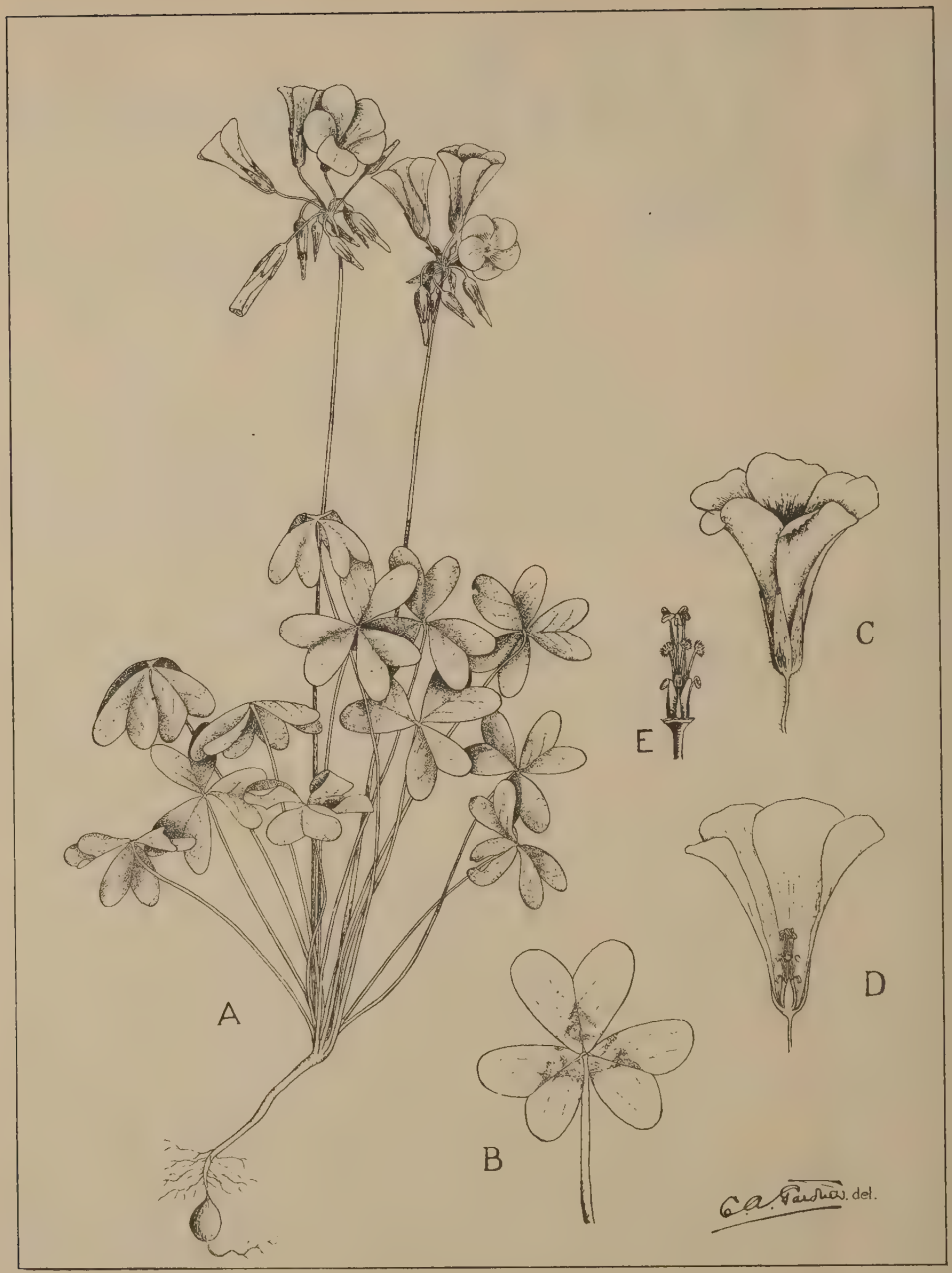
The date and method of introduction to Western Australia are uncertain but it is now widespread throughout the South-West and also occurs in the Avon Valley and parts of the Great Southern district.

#### DESCRIPTION

The name "soursob" is a variation of "soursobs" more frequently used when it first appeared in Australia and undoubtedly is derived from the sour taste of the leaves. Until recently *O. pes-caprae* was known as *O. cernua. Oxalis is the* Greco-Latin name for some plants with bitter leaves. *Cernua* describes the drooping flowers while *pes-caprae* means the foot of a goat and alludes to the shape of the leaflets.

It is an almost glabrous perennial with a vertical subterranean rhizome up to $\frac{1}{3}$ in. thick at ground level, but tapering into a fine thread attached to the parent bulb or root. The rhizome has numerous adventitious roots and also produces one to several bulbils in the axils of small scale-leaves. A cluster of typical leaves is formed at ground level. Each has a short flattened base, a long cylindrical stalk and three terminal, clover-like leaflets, often marked with small purple spots. The flowers are yellow, drooping and clustered in umbels of 3-16 on long peduncles. The capsule is pointed-oblong but rarely matures in Australia. Flowering usually occurs from June to October.

Although the leaves could be confused with those of clovers the flowers are very different and the plants are not closely related.




SOURSOB *(Oxalis pes-caprae* L.)

A—Complete plant showing bulb; B—Leaf; C—Flower; D—Section of flower; E—Stamens

(From a pen-drawing by Mr. C. A. Gardner)

## SIGNIFICANCE

In this State, soursob occurs in many orchards and is also a troublesome weed of crop land and pastures, especially in moist situations. Despite the delicacy of its structure the plant provides keen competition for other herbage, aided by the fact that development from bulbs and corms is usually more rapid than from seed. The prolific bulb formation gives rise to a dense mass of plants which tend to smother the less vigorous pasture species and can also affect the yield of cereal crops.

Owing to a high oxalic acid content—the cause of the sour taste—soursob is not eaten readily by stock. On occasions, however, because of the absence of more palatable herbage, sheep have eaten this weed in quantity and cases of chronic oxalic acid poisoning have occurred. Wethers have remained healthy when trouble has been experienced with ewes apparently associated with the greater calcium requirement of ewes, especially when pregnant. All classes of sheep, however, can be affected.

The poisoning is considered to be due to the absorption of the oxalic acid into the animal's system to form calcium oxalate making the body deficient in available calcium. The disease usually does not appear until the animals have been grazing on the soursob for some time. Sheep reared in districts in which the plant is prevalent are less likely to be affected than animals introduced from an area where the weed does not occur.

In some cases the animals have died suddenly, in others they have lingered for some time. A stiffness in gait is followed by loss of control of the hind quarters and at times, also the forequarters.

## CONTROL

As soursob is very difficult to eradicate, it is important to prevent it from becoming established. It is spread by a number of means, including stock, farm implements and running water, but has also been distributed both as a garden plant and in the soil around shrubs and fruit trees. "Balled" trees and shrubs should be examined prior to planting to ensure that they are not carrying bulbs of soursob or, for that matter, other undesirable weeds. If only a few plants appear they should be dug out immediately.

The above-ground parts of soursob can be destroyed by the application of a 5 per cent. solution (1 lb. per 2 gallons) of sodium chlorate, but, owing to the cost, this method is only practicable for limited areas. In order to prevent the formation of new bulbs, spraying must be carried out early in the season when a general emergence of the plants has occurred but before flowering has commenced. Even if done at the optimum growth stage, eradication cannot be expected from a single application.

As already mentioned, grazing does not provide an effective method of control but a substantial reduction can be brought about by ploughing and cultivation. Some work undertaken by Michael in South Australia showed that after a favourable season, there could be three tons of bulbs per acre while areas subjected to two workings produced only 7 cwts. per acre.

In South Australia, where the weed occurs freely on wheat land, ploughing is recommended when the old bulbs are nearing exhaustion—usually between late May and the middle of June. A further cultivation is carried out in late July or early August to prevent the formation of new bulbs on plants that survived the ploughing. These two workings can often be followed by the sowing of an early maturing cereal. The procedure outlined does not eradicate soursob but reduces its intensity so that a more satisfactory crop may be grown. Once the weed is established, eradication cannot be expected unless control measures are repeated in a thorough manner for several years.

Soursob is resistant to the commonly used hormone-like herbicides but the search is being continued for an effective chemical treatment. The possibilities of biological control have not been overlooked.

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# The Fruit Industry IN OTHER LANDS

By F. MELVILLE, B.Sc. (Agric.),
Horticultural Adviser

## 5.—THE UNITED STATES OF AMERICA (continued)

## STONE FRUITS

**THE United States grows in the vicinity of 64 million bushels of peaches, 83,000 tons of plums, 470,000 tons of prunes and 225,000 tons of apricots. About half the peaches and the major portion of the plums, prunes and apricots are grown in California which is the centre of the canning industry. There is also a large cherry industry concentrated mainly in the eastern side of the country. Production amounts to almost 100,000 tons of sweet cherries and 125,000 tons of sour varieties.**

### PEACH BREEDING

Peach breeding has proved very profitable in terms of the number of new varieties which have been released in recent years. These releases of both dessert and canning types have been the result of programmes in operation at many centres. This was discussed with Dr. Havis at the U.S.D.A. Plant Industry Centre at Beltsville, Maryland, where 6,000 to 8,000 seedlings from known crosses are raised each year. Of the 140,000 seedlings which have been raised over the years, 14 have proved of commercial value.

The technique adopted is as follows. The flowers are emasculated just as the petals begin to show by pinching off the anthers with the thumb and forefinger or with forceps. Emasculation is far more critical in timing than pollination and must be done at the right time even at the expense of pollination..

Prior to blossoming the whole tree is enclosed by a muslin framework to exclude insects and also provide protection to the young blossoms from adverse weather conditions. By this means setting is improved and 60-70 per cent. set can normally be obtained. The cover is retained for four to six weeks.

### PEACH VARIETIES

Research has been aimed at producing varieties with improved quality and characteristics suited to growing or marketing conditions of a particular area. One important feature considered has been ability to stand mild winter conditions. A number of dessert varieties with low chilling requirements has been released and some of these could be useful under Western Australian conditions.

The following are varieties considered worthy of trial.

**Maygold.**

Yellow-fleshed medium-sized semi-cling. Ripens 6 six weeks ahead of Elberta. Very low chilling requirement—650 hours below 45° compared with 850 hours for Elberta.

**Red Cap.**

Yellow-fleshed medium-sized cling, good colour. Ripens nearly seven weeks ahead of Elberta. Low chilling requirement of 750 hours below 45°.

**Coronet.**

Yellow-fleshed medium-sized semi-cling but near free-stone when ripe, good colour. Ripens nearly six weeks ahead of Elberta. Very low chilling requirement of 700 hours.

Fig. 44—Stone fruit on the Display Floor at the Washington Street Auction Markets, New York

**Red Globe.**

Yellow-fleshed medium-sized red-centred free-stone. Ripens with Halehaven but brighter colour. Chilling requirements comparable with Elberta.

Two other promising varieties with low chilling requirements being planted extensively are Southland (750 hours) and July Elberta (800 hours). These have already been introduced into Western Australia. Another variety which is becoming very popular in California is Fay Elberta which is being planted in place of the standard Elberta.

One of the earliest peaches is Springtime a white-fleshed cling which ripens the equivalent of the third week in November in the southern hemisphere. It has a very low chilling requirement of 600 hours.

New canning peaches which have been released in recent years are Dixon 1 (Dix 6-6) and Dixon 2 (Dix 6-8). Both have superior quality to the general run of cling types are good producers and trees make vigorous growth. They are red centred and the red tends to diffuse into the flesh when fully ripe.

## ROOTSTOCKS

Commercial peaches are normally propagated on seedlings such as Lovell or Elberta. Nematode resistant stocks are also available. Those seen were 2341 at Beltsville and FV 234-1 at Fresno. Both show good resistance to Meloigadyne Juvanica and incognita (acrita). S.37 is another stock with nematode resistance.

White Damson, an Institia plum, has proved useful as a stock for peaches under wet conditions.

Marianna 2624 plum stock shows resistance to Armillaria.

Plums on peach stocks appear less susceptible to Bacterial Canker.

## HERBICIDES

Trials have shown that dalapon at the rate of 7 lb. plus Monuron at 3 lb. per acre applied in a 4 ft. square around the tree is effective against grasses. A 10 per cent. reduction in tree growth occurred when the spray was extended beyond the drip ring.

Amino triazole at 5 lb. per acre gave effective weed control without tree injury.

## SOIL FUMIGATION

Nemagon applied at 2½ gallons per acre to peaches as a control for root knot and lesion nematodes, gave a 33 per cent. increase in growth. Trials included the use of emulsible concentrate introduced ahead of the pump into the irrigation line for distribution in the irrigation water.

## CHEMICAL THINNING

The only material showing promise for peaches is 3 chlorophenoxy propionic acid

(3.C.P.) which is still under trial. Trials consisted of applying 100 ppm and 300 ppm at 10 days and 20 days after full bloom as respective treatments. Higher concentrations are likely to overthin. 3 C.P. has also proved effective on plums but at much lower concentrations in the region of 25 ppm. It is unsatisfactory on apricots.

## MEASUREMENT OF PEACH MATURITY

Some basic work is in progress at the U.S.D.A. Plant Industry Centre at Beltsville to study methods for determining peach maturity on a commercial scale. By the use of a spectrophotometer the changes in chlorophyll and carotinoid pigments in the ripening peach is being followed with a view to accumulating data which can be used to determine standard measurements of maturity. It is hoped to build a simplified machine capable of sorting fruit into various categories based on maturity for use by the canning industry.

## NEW PLUM VARIETIES

Several varieties have been released in recent years as a result of breeding work conducted at Davis by Professor Hesse. Work is also in progress at the U.S.D.A. station Fresno.

Varieties worthy of note are:—

**Burmosa.**

Pink-skinned, amber-fleshed, pleasantly sweet. Ripens same time as Beauty and could provide suitable substitute. Almost free-stone. Santa Rosa or Mariposa are suitable pollinators.

Fig. 45—Elberta peaches growing under sod in Wenatchee, Washington. Clean summer cultivation is the general rule

**Laroda.**

Deep reddish purple, light-fleshed, large round fruit, good quality. Ripens three to four weeks after Santa Rosa.

**Nubiana.**

Deep red with light amber flesh, very firm and holds well on the tree, good quality. Ripens about four weeks after Santa Rosa.

**Queen Ann.**

Large dark red with amber flesh, good quality. Holds well on tree and could be stored for a considerable period. Ripens five weeks after Santa Rosa. Wickson and Santa Rosa suitable pollinators.

### VIRUS INDEXING

Fundamental work on stone fruit viruses is being carried out at the Tree Fruit Station at Wenatchee. Sap transmission from living tissues using carborundum as an abrasive is the technique being used. The Chicago Pickling variety of cucumber is used for indexing for ring spot and sour cherry yellows. *Physalis flaidana* used for indexing apple mosaic was being tried for plum line pattern.

At Davis virus-free material of the leading cherry varieties is now available. The parent material is kept in a screen house and is only used for supplying certified buds to nurserymen to establish their own mother trees. Work is now being commenced on peaches. Initially peach cuttings are being raised under mist in a screen house to provide rootstock material.

Seedlings are not used on account of certain seed-borne viruses.

### HANDLING AND PACKING

Stone fruits are handled in field lugs, the packing being done either in mobile field units or in a packing shed.

Market containers vary considerably, but are normally some type of wooden tray. For instance the California peach box measures 11½ x 16½ in. and may vary from 4 to 5½ in. in depth. The fruit is usually packed in two layers using fancy paper cups or moulded paper fillers to separate the fruit. A light flexible unitised lid covers the box which is not completely filled. Packs are very attractive.

Plums normally go into square boxes. The special plum boxes measure 12½ x 12½ in. and up to 7 in. deep.

Polythene lined boxes are a feature of cherry packing.

## GRAPES

**COVERAGE of the grape industry of California was limited to four days and included discussions with Professor Olmo at the University of California, Davis, and in the field, visits to commercial grape packing houses and inspection of grape fumigation trials. Time did not permit a detailed examination of cultural practices.**

The United States produces almost 3 million tons of grapes of which 2½ million tons are grown in California on approximately 425,000 acres. Californian varieties are European types, but elsewhere they are mainly American types used for fresh and frozen juices.

California produces vast quantities of grapes for wine, in fact over half the total production goes for wine which in 1958 amounted to over 150,000,000 gallons. Raisin varieties account for about half the total area of vines in California and about 40 per cent. of the world's production. Large quantities of Thompsons Seedless go for wine and to the table grape trade. Table grape production amounts to 500,000 tons.

The various varieties of grapes tend to be concentrated in areas specially suited to the variety. This leads to a high degree of specialisation both in the growing and handling of the crop.

The San Joaquin Valley is the main centre of California grape growing and contains over 80 per cent. of the State acreage. Fresno county in the centre of the valley is the largest concentrated vineyard area for raisin and dessert wine production. Just south in Tulare county is the centre of late table grapes particularly Emperors while in the north the Lodi area is noted for its Flame Tokay.

One of the newest grape areas is the Desert of Southern California encompassing the Imperial and Coachella Valleys. Here are grown early-maturing table grapes which are marketed as from about the third week in May and bring high prices. Over 80 per cent. are Thompson Seedless but the new early selections Perlette and Delight are also becoming prominent.

Grape soils in California are mainly deep alluvial sands and loams and yields are high. The average for all types of grapes is over 5½ tons per acre.

Fig. 46—Californian vineyards

## VARIETIES

The Thompsons Seedless holds first place with over 40 per cent. of the total Californian acreage and is the most versatile variety. It is grown for the early market in southern counties, is also a very important table variety in central California, is the principal raisin grape and is also used for wine as well as canning. The American consumer likes a seedless grape and Thompsons are very popular. Emperor is the leading table grape and in Tulare county alone over 5 million boxes are produced. Much of its popularity stems from its good storage and shipping qualities enabling fresh grapes to be marketed practically through to the commencement of the early grapes the next season. Colour is sometimes inadequate by American standards but samples seen were very good in this regard.

Tokay is particularly suited to the Lodi area where it is extensively grown. During the past season heavy rain during harvest caused excessive berry splitting and prevented the marketing of a large proportion of the crop.

Almeria is planted on a more limited scale and used both for local marketing and export. Adequate set is obtained by natural pollination. Some growers interplant with Red Malaga but it is usual to rely on pollen from adjacent plantings often of Red Emperor. At blossoming time growers are advised to run air blast sprayers through adjacent rows with the air stream directed upwards to blow the pollen into the air. Calmeria is now being planted as a long storage variety and will compete with Almeria. Berries are rather larger and longer but flavour is not improved.

Other main table varieties are Ribier, Muscats, Red and White Malagas and Cardinal.

## NEW RELEASES

About eleven years ago the University of California, Davis released early varieties, Perlette and Delight and these have been planted in increasing quantities in early districts such as the Coachella Valley. Perlette is now the earliest variety grown, ripening 14 to 20 days ahead of Thompson Seedless. In 1958 over 160,000 boxes were marketed and production is expected to increase substantially. Prices have been in the vicinity of $7.50 per box (£3 7s. 6d.).

It is a white grape, thin-skinned and seedless, fairly good berry size but sugar generally low and palatability only fair. The vine is vigorous and crops well with spur pruning.

Delight is in a less favoured position as a table grape since it ripens about one week later than Perlette. The berries are white, seedless, thick-skinned and firmer than Perlette with a high sugar content. Grapes are of excellent quality and make a good type of raisin.

Fig. 47—Professor H. Olmo standing against a newly developed grape stock Vinifera X Rotundifolia — important for its resistance to nematodes

Other releases are Early Muscat, which is at least a month ahead of other Muscat varieties, July Muscat ripening a little before ordinary muscats but with a much firmer berry, and Gold which ripens with the ordinary muscats. Coloured varieties are Queen which is similar to Tokay but better coloured and slightly earlier and Beauty Seedless, a black variety.

Cardinal which has virtually eliminated Red Malaga was released by the U.S.D.A. in 1946.

## TABLE GRAPE SELECTIONS UNDER TEST

The present breeding programme for table grapes operated from Davis is aimed at producing new selections which have similar characteristics to well-established varieties but with improved colour, larger berry size, better bunch characteristics, higher soluble solids and high yields. Selections based on Emperor, Thompsons Seedless, Almeria and Ribier are under test. All selections are seedless or nearly so and have the capacity to yield heavy crops. All are spur bearing. It is felt that the introduction of a selection which is essentially an improvement of a well-tried popular variety will be much simpler than trying to establish an entirely new variety on the market.

Breeding work is also being carried on by the U.S.D.A. at Fresno by Dr. Weinberger.

## PROCESSING

Increasing quantities of seedless grapes are going into canning for use in fruit salads. Breeding work is in progress to develop improved varieties—essentials are ease of shattering and seedlessness.

## NEW WINE VARIETIES

Recent wine grape releases are Rubired (Alicante Ganzin x Tinta Cao); Royalty (Alicante Ganzin x Trousseau) a port type; Calzin—a red Zinfandel type; Helena—dry white, and Flora an aromatic Treminina type.

Ruby Carbenet and Emerald Riesling were released several years ago. Improvements achieved with the new wine grapes

are high yields, and ability to produce grapes suitable for dry wines under Californian conditions.

## VINEYARD MANAGEMENT

In the main vine areas of California the soils are sandy and Phylloxera is not a problem. As a general rule therefore, new vineyards are set out as rooted cuttings or less frequently as unrooted cuttings. Normal spacing is 8 to 10 ft. in rows 12 ft. apart. Vertical trellising is usual for Thompsons but for Emperors a two-wire sloping T is general. Tokay and wine varieties are normally trained as bushes on vertical stakes and Almeria on overhead trellis.

Fig. 48—Red Emperor vines side-trimmed just before harvest to improve colour

With the exception of some coastal areas vines are irrigated usually from 24 to 60 in., according to location. Summer cultivation is general although a few growers of table grapes are trying mowing the summer growth. Cover crops are not widely used. Girdling is practiced on Thompsons to improve berry size and in some areas for earliness. Hand thinning is common on table varieties. Both girdling and thinning are costly items and in the breeding programme close attention is being paid to openness of bunch and berry size to eliminate the need for thinning. Heavy thinning of the foliage of Emperors prior to the grapes ripening was being practiced io induce better berry colour.

The climatic conditions of California are apparently not suitable to the development of Anthracnose and no spraying is necessary for this disease. Sulphur is the main fungicide applied for the control of Oidium.

## HARVESTING AND PACKING

The grape-growing areas of California have low rainfalls, and normally fine warm weather prevails through harvest. It is therefore possible to dry Thompsons outside without dipping. The grapes as picked are placed on paper trays 2 ft. x 3 ft. laid on the ground between the rows and allowed to dry in the sun. When dry each lot is rolled up into a package for transport to the packing house. If rain occurs during the drying period considerable

damage can occur unless the grower is able to roll up his fruit ahead of the rain. Dried Thompsons are referred to as raisins and are dark in colour.

Fig. 49—Thompson Seedless grapes (Sultanas) dried in the vineyard are known as raisins. Rack drying is unknown

Table grapes are either trimmed and packed in the vineyard rows or transported to the packing house in field boxes in the normal way.

Where vineyard packing is practised, the bunches are trimmed by the picker and placed directly in the market containers which then go to the packing house for checking weight and quality. The usual box is the L.A. lug measuring 16⅛ in. x 13½ in. x 3¾ in. inside measurements with a two-piece liner and crinkle board base. It contains 28 lb. of fruit. Flexible lids incorporating 1½ in. x ¾ in. cleats are applied with mechanical nailing machines. For marketing within the State an open lug 20⅝ in. x 13½ in. x 7 3/16 in. with ¾ in. cleats is commonly used. This box is unlined and unlidded and returnable. Grapes in all packs are packed stems up as a requirement of the trade. Grapes packed in the shed come to the packers in boxes on mechanical conveyors and are inspected and trimmed before being placed in the box. The packing stands incorporate scales which enable filling to a definite weight. The boxes are then placed on another conveyor to take them to the lidding machine.

## EXPORT PACKS

The export chest measures 18¾ in. x 14 15/16 in. x 7¾ in. (inside) and is packed to a guaranteed nett weight of 34 lb. An excelsior pad containing woodwool is placed in the bottom of the box. The grapes are packed without sawdust and after fumigation are placed unlidded in cool store. Periodic fumigation takes place until the grapes are required for shipment when 12 lb. of special pine sawdust incorporating sodium bisulphite is added to each box and vibrated through the fruit before lidding. Grapes are shipped to southern American countries and also the Far East. Emperor, Almeria and Ribier are important export varieties.

## FUMIGATION

Fumigation with sulphur dioxide is now standard practice for all table grapes whether destined for storage or immediate shipment. Storage fruit is fumigated either in special chambers before going into store or in the pre-cooling chamber. As sulphur dioxide is very corrosive, special precautions are taken to prevent the gas coming in contact with the cooling soils. Grapes for immediate shipment are fumigated in the rail cars or road trucks.

Sulphur dioxide has a surface sterilising effect and therefore fumigation should be carried out after all likely injury to the fruit has occurred viz., after packing.

The sulphur dioxide is supplied either in small cylinders containing measured dosages or else the liquid is measured in a dispenser. Either way 0.5 per cent. to 1 per cent. gas is introduced and immediately circulated to obtain uniform distribution. This is important to prevent injury from excessive concentration in some spots and insufficient absorption in others.

The gas is absorbed rapidly by both the grapes and boxes during the first 10 minutes and over 90 per cent. usually disappears within 20 minutes. Damp boxes absorb more than dry ones and absorption is greater at low temperatures. As the number of boxes in the chamber increases, the dosage must be increased to allow for the additional absorption. Grapes in store are regassed at approximately weekly intervals at 0.25 per cent. $SO_2$. Thompsons Seedless can normally be stored for six to eight weeks, Tokay eight weeks, Ribier 12 weeks and Emperor five months. With the early and late districts and long storage of Emperors it is possible to have grapes on the market most of the year.

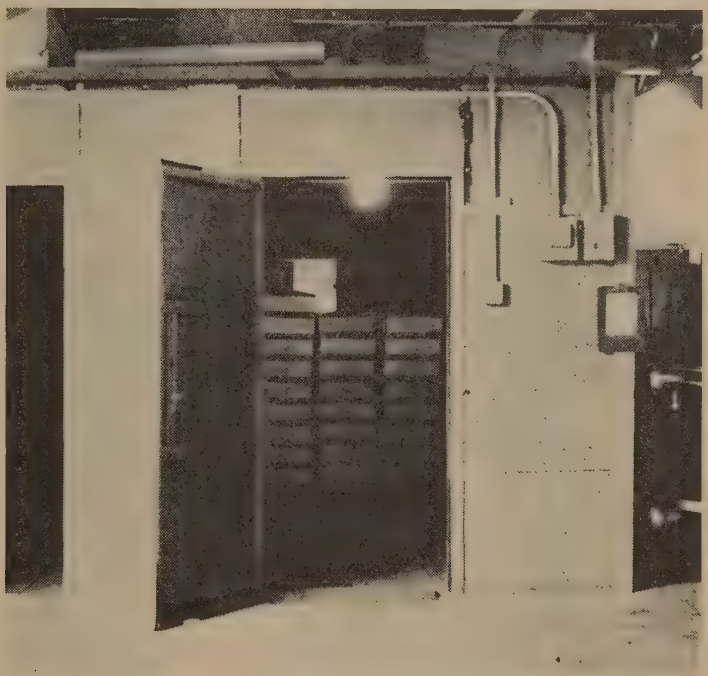

Fig. 50—All grapes are fumigated with sulphur dioxide gas after packing, either in a simple type of chamber as shown or in cool store

It is most important to pre-cool grapes as soon as possible after picking to preserve the greenness of the stems and the firmness of the berries. It is common for grapes to go into the pre-cooling chambers within an hour or two of picking and be fumigated overnight. The temperature at which fumigation is carried out appears to have little effect on the effectiveness of the treatment.

## GRAPE BREEDING

The breeding programme covers three main classes of grapes:—

(a) Table grapes.
(b) Wine grapes.
(c) Canning varieties.

Briefly the procedure is as follows:—

Seedlings are raised in the glasshouse in fibre cups during the winter, hardened off in the spring and put out into the field in closely planted rows. The resultant "seedling block" provides the initial selection over three years for such factors as vigour, yield, bunch characteristics and quality. In table grapes, bunch size, berry size, looseness of cluster, colour, seedlessness as well as time of ripening and storage quality are also taken into consideration. For wine types, samples of wine are made from the grapes for assessment. One of the essentials for canning grapes is ease of shattering. All seedlings are spur pruned which automatically eliminates rod bearing types.

After three years, promising selections from the seedling block go into a "Trial Block" where a number of vines of each selection are grown to afford a more accurate assessment. From the trial block, final selections are made for naming. Material for commercial distribution is raised in the Multiplication Block. Specimen vines of each selection go into the Foundation Block for permanent holding. Seedlings not suitable for commercial selection but carrying some desirable characteristic go into the "Breeding Block" for use in further crosses as required.

## VIRUS INDEXING

Indexing varieties now being used include:—

St. George for fan leaf.

Mission for fan leaf, yellow mosaic and leafroll.

41B as a quick indicator for vein banding and also for yellow vein.

Carignane for yellow vein.

Emperor is not used to any extent because of the time interval involved in developing symptoms.

The procedure adopted is to strike cuttings of indexing varieties in the greenhouse, transfer to the lathhouse for budding with scion material under test and planting out in the field in the spring. The buds do not grow but transmit any virus they are carrying to the index plant. Growth is watched for two to three years for virus symptoms. A foundation block of indexed varieties is maintained as a source of clean material. Visual inspection is made twice annually and the vines are re-indexed every four years.

## HERBICIDES

Herbicides are not yet widely used in vineyards but trials have demonstrated the value of diuron as a weed control material applied as a 4 ft. band in the vine rows. Application at 4 lb. per acre covered has proved to be very effective but it is not recommended for use on vines younger than 4 years because of possible damage. Application in autumn or winter is recommended. Some damage has been noted when applied at 4 lb. per acre in spring or early summer and the effect on weeds is more erratic. Diuron acts as a soil sterilent and for best results should be applied before seeds germinate. It has limited effect on some established weeds and practically none on some perennials such as Johnson grass.

Fig. 51—Grapes packed for local markets ready for cold storage prior to dispatch

## SOIL FUMIGATION

Fumigation of established vines with Nemagon has so far not proved an economic proposition. Trials are at present in progress using water-dispersible material which is flooded on and it was thought results were more promising.

## ROOTSTOCKS

Rotundifolia is highly resistant to pests and diseases but cannot be successfully propagated from cutting. As a result of

crossing with a vinifera type, a hybrid has now been selected with quite good propagating qualities and retaining a high degree of resistance to nematodes and phylloxera as well as leaf hoppers and mites. This could be very useful on sandy soils and worthy of trials under Western Australian conditions.

Work being conducted by the U.S.D.A. at Fresno has led to the production of two promising rootstocks F131 and F154 both Dog Ridge x 1613 crosses which show considerable resistance to nematodes and phylloxera. These are still undergoing further tests and have not yet been released.

## GENERAL

**TRIALS with seven olive varieties have shown that flower formation and yields are related to the amount of winter chilling. Under mild winter conditions, many varieties set little if any fruit. Azapa, a variety with low chilling requirements, is being tried in Southern California and could be useful in Western Australia.**

Seedling rootstocks have been found to exert a distinct influence on tree growth and yields. Of three varieties tested, Mission and Manzanillo did very much better on their own roots than when worked on seedling stocks. Sevillano however, was equal or slightly better on seedling stocks than on its own roots.

### WALNUTS

Payne, Erhart and Early Erhart varieties all have low chilling requirements and may suit Western Australian conditions. The Paradox stock has proved superior for walnuts but is harder to propagate. However, there has been some success in propagating it vegetatively.

During periods of wide temperature fluctuations bleeding is a problem in budding. Slashing the bark or boring the stock above ground level shortly before budding will often times assist the position by relieving the pressure of sap.

### SOIL FUMIGANTS

Fumazone is now available as an addition to fertiliser pellets, for use as soil applications prior to planting and as side dressings for row crops. The fumigant is lost fairly rapidly and the pellets must be used fairly soon after manufacture.

Methyl bromide is now available dissolved in a solvent so that normal liquid injection is possible. After injection the soil is covered (within 15-20 minutes) with a polythene sheet. Less fumigant seems to be required under these conditions.

Nemagon should not be used with soil temperatures above 90° due to excessive vapourisation.

In 1957, 500,000 acres in the United States were fumigated with various fumigation materials covering a wide range of crops.

### MEDITERRANEAN FRUIT FLY

It is now two years since the last fruit fly was trapped in Florida in the eradication campaign which cost 10 million dollars and covered an area of 800,000 acres in the largest citrus area of the United States.

The basis of the campaign was detection by trapping followed by rapid knock-down with sprays developed in the fruit fly laboratories in Hawaii. Malathion and hydrolysate of yeast sprays were applied from the air at seven to ten day intervals to coincide as nearly as possible with fruit fly emergence periods. When rain occurred additional sprays were applied. Spraying was normally continued for 30 days after the last fly was found, to cover the expected life cycle of eggs already laid. As a result of the intensive campaign 14 sprays were the most needed to eradicate the pest. A single spray cost about one dollar per acre.

Special transparent plastic traps incorporating a male lure of angellica oil and later synthetic materials were used. Altogether 50,000 traps were in use at the height of the campaign and large numbers are still maintained in the field to check on reinfestation.

No fruits were gathered or destroyed as in the 1929 campaign. The only real damage to property was the spotting of paint on motor cars exposed to the spraying.

Recently a new lure has been developed known as Medlure manufactured by Trubeck & Co., of East Rutherford, New Jersey.

### MALE STERILISATION

Work is in progress on the control of Oriental Fruit Fly and Melon Fly by means of male sterilisation and full scale trials are scheduled for 1960 possibly on an isolated Pacific island. Later trials are planned with Mediterranean Fruit Fly. The method is based on the successful work with screw-worm eradication.

Laboratories for breeding flies were built and equipped at a cost of one million dollars in Hawaii and to date some 20 billion flies have been bred. The eggs are obtained by inducing the female fly to oviposit through perforations in hollow waxed cups containing papaw attractant. The larvae are raised on a base of carrot plus protein. Sterilisation of the larvae is affected by exposing them to irradiation from cobalt 60. After pupation the flies hatch out normally but males are sterile.

Eradication by this means depends on flooding the population in the trial area with sterile males at the rate of something like ten times the normal male population so that the chance of fertilisation is greatly reduced. By maintaining this high level of sterile males by continual releases it is hoped to eventually achieve eradication as in the case of the screw-worm.

### ACKNOWLEDGMENT

Arrangements to visit horticultural centres in England were completed by the Australian Liaison Officer in London and were made possible by the courtesy of the Director and Staff of the Horticultural Research Station, Long Ashton, the East Malling Research Station and the National Agricultural Advisory Service of the Ministry of Agriculture.

In the Netherlands arrangements were in the hands of Mr. Danniels of the Ministry of Agriculture who organised visits to the International Agricultural Centre, Wageningen and also Horticultural Stations at Wilhelminadorp and Naaldwijk.

Visits to experimental stations and fruit-growing areas in the United States were made possible by the courtesy and co-operation of the Agricultural Research Service of the United States Department of Agriculture, New York State University, the Washington State College, the University of California and County Extension Services. The itinerary was arranged in conjunction with Professor R. M. Smock of Cornell University and the Australian Agricultural Attache in Washington.

Full measure of co-operation was freely given at all centres in the various countries visited and everything possible was done to facilitate contacts with research, extension and industry representatives.

I should like to make sincere acknowledgment of the help, courtesy and hospitality extended by the many people I met and who by their efforts ensured a most interesting, profitable and enjoyable trip.

Finally I should like to acknowledge the part played by the Western Australian Fruit Growers' Association in contributing substantially towards financing the trip.

THE END

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# Honey Flora Calendar for November

## COMPILED BY R. S. COLEMAN, APICULTURAL SECTION, WITH ASSISTANCE FROM THE BOTANICAL BRANCH

| Common Name | Botanical Name | Where Found | Honey | | Quality of Pollen | Remarks |
|---|---|---|---|---|---|---|
| | | | Quality | Quantity | | |
| Poot .... .... .... | *Eucalyptus decipiens*, Endl. | In the mallee areas in the Great Southern and the lee side of limestone hills in the Wanneroo area | Good .... | Good .... | Good .... | The tree looks very much like a Tuart in the coastal areas, is usually mallee in the outer wheat belt. Beekeepers along the coast regard it as a fairly reliable producer, but as it only occurs in small stands is not of very much importance. |
| Snap and Rattle, Yorrel, or Small-budded Mallee | *Eucalyptus gracilis*, F. Muell. | Widespread throughout the State, ranging from Salmon Gums to Coorow | Good .... | Good .... | Good .... | Very different reports about this tree from various areas. Some areas report excellent flows and high quality honey, in others the tree is not regarded as a nectar bearing tree at all. |
| York Gum .... .... | *Eucalyptus loxophleba*, Benth. | From the Murchison River on the road to Carnarvon to the Great Southern, and Salmon Gums | Good .... | Excellent .... | Poor .... | Major honey plant, but is deficient in pollen when the Cape Weed is in flower, it will produce quite a large surplus. Bud development is about 9–10 months. As it grows on good agricultural areas, most of it has been cleared. |
| Bell Mallee .... .... | *Eucalyptus preissiana*, Schau. | Stirling Range and Albany districts | .... .... | .... .... | .... .... | Many reports of the blossoms being worked by insects reported to be quite a lot of nectar in the base of the flowers. This is a tree we would like more reports about. |
| White Gum or Wandoo | *Eucalyptus redunca*, Schau. | Spring White Gum is found mainly on the tops of the hills. Starting mid-September and going through to Xmas time in the area from Bolgart to Wandering | Excellent .... | Excellent .... | Poor .... | Honey—late spring early summer. Seems to open earlier on gravelly hills in the Dale, York and Wandering areas. |
| Chittick .... .... | *Lambertia inermis*, R.Br. | Southern sand plain .... .... | Good .... | Good .... | Good .... | Flowers most of the year with its flush period in Spring. Regarded as a good flower by local beekeepers. |
| | *Dryandra polyciphala*, Benth. | Gravelly hills north of Perth .... | Poor .... | Poor .... | Good .... | More information would be appreciated on this plant. |
| Holly Leaf Banksia | *Banksia ilicifolia*, R.Br. | Coastal sand plain .... .... | Good .... | Good .... | Good .... | Uncertain yielder, and has a long flowering season. |
| River Gum .... .... | *Eucalyptus camoldulensis*, Dehn. | North-eastern portion of the State | Good .... | Good .... | Good .... | Changes into Flooded Gum as it comes south. One of the major honey plants of the Eastern States and produces quite a lot of honey. |
| Lemon-scented Gum | *Eucalyptus citriodora*, Hook. | Planted extensively around Perth. A native of N.S.W. | Good .... | Good .... | Good .... | A number of beekeepers have reported flows from this source. |
| Clevelands Black-butt | *Eucalyptus Clelandi*, Maiden | .... .... .... .... .... | Unknown .... | Unknown .... | Unknown .... | From reports from non-beekeepers, this could be one of our future honey plants. |
| Rough Fruited Mallee | *Eucalyptus corrugata*, Luehm. | Grows between Westonia and Southern Cross | Unknown .... | Unknown .... | Unknown .... | From reports from non-beekeepers, it is a long flowering tree. |

| | | | | | |
|---|---|---|---|---|---|
| Yellow Tingle ... | *Eucalyptus Guilfoylei*, Maiden | Southern coastal forests, usually found on river, creek banks and valleys | Good .... | Good .... | Good .... | This tree has been reported as a most unreliable producer as it seems to be sensitive to cold weather. |
| Lerp Mallee .... | *Eucalyptus incrassata*, Labill. | Widespread .... .... .... | Good .... | Good .... | Good .... | Many different reports. Information is needed on this plant. |
| Angular Mallee .... | *Eucalyptus incrassata*, Labill. Var. *angulosa* or *E. angulosa* | Very widespread .... .... | Good .... | Good .... | Good .... | Reported as a good honey producer in the Eastern States. Is not worked by beekeepers here. |
| | *Eucalyptus leptophylla*, F. Muell. | Widespread .... .... .... | Good ? .... | Good ? .... | Good ? .... | Differing reports, most of them saying this tree is of little use to the beekeeper. Honey as said in one report; flow thin and light in colour with mild flavour. |
| Jarrah .... .... | *Eucalyptus marginata*, Sm. | One of the main forest trees in Western Australia | Good .... | Good .... | Excellent .... | One of the major honey plants. It needs a wet spring to set its buds. A dry but humid early summer to produce heavily. The coastal jarrah seem to produce better than hills jarrah. |
| Crown Top Mallee .... | *Eucalyptus pileata*, Blakely | .... .... .... .... .... | Unknown .... | Good ? .... | Good .... | One of the varieties we need more information about. |
| Karri .... .... | *Eucalyptus diversicolor*, F. Muell. | .... .... .... .... .... | Excellent .... | Excellent .... | Poor .... | The major flow starts in November-December. However, if bees are taken down in this time into the forest the intermittent flow from the Karri due to rain will cause excessive swarming. |
| Diamond Bush .... | *Bossiaea laidlawiana*, Tovey et Morris | In the karri forest .... .... | Good .... | Good .... | Excellent .... | One of the best pollen plants we have here in Western Australia. Its main disadvantage is that it tends to make the hives swarm. |
| | *Dryandra stupposa*, Lindl. | Great Southern .... .... | Good .... | Good .... | Good .... | Only one report from a beekeeper. More information is needed. |
| Honeysuckle .... | *Lambertia multiflora*, Lindl. | .... .... .... .... .... | Good ? .... | Good ? .... | Good .... | Red flowers on the sand plain and yellow flowers in the Darling Range and south. |
| Silver Banksia or Yellow Banksia | *Banksia attenuata*, R.Br. | Coastal plain .... .... .. | Good .... | Good .... | Good .... | Regarded as a very good producer by those beekeepers who work the area wherein it grows. |
| | *Melaleuca cuticularis*, Labill. | Southern coastal swamps and Stirling Ranges | Good .... | Good .... | Good .... | |
| Coastal Paper Bark | *Melaleuca pauperiflora*, F. Muell. | Swamp .... .... .... .... | Good .... | Good .... | Good .... | Not extensively worked by beekeepers. |
| Taylorina . .... | *Psoralia pinnata*, Linn. | Albany area .... .. .... | Excellent .... | Excellent .... | Excellent .... | Connoisseur's honey. Very limited area. The honey is greatly sought by those who appreciate good honey. |
| Wild Hops .... .... | *Chorilaena hirsuta*, Benth. | Coorow .... .... .... .... | Good .... | Good .... | Good .... | Bees work this in the rain as flowers are abundant. 50 lb. is the average usual from this flow. The activity of bees on this flow seems to be associated with the weather conditions. Flowers over a long period. |

It will be seen from this list that information concerning many nectar-bearing plants is far from adequate. We would appreciate further information from beekeepers.

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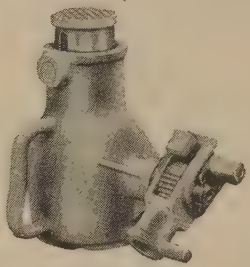

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# Can HEIFERS BE FED TOO WELL?

By L. C. SNOOK, D.Sc., Animal Nutrition Officer

**DURING recent years, emphasis has been given to the results of experiments conducted overseas, which appear to show that when heifers are generously fed, this reduces their ability to produce milk in later life. As a result, some dairymen now believe that heifer calves should be kept lean rather than in prime condition. It has become common to hear statements to the effect that generous feeding encourages calves to become "beefy," at the expense of the milk-producing attributes which are essential in a dairy cow.**

Many dairymen must have felt that there was something wrong with this assumption. If a well-fed heifer runs to beef, surely this is indicative of bad breeding rather than bad feeding. Lovers of well-fed animals will be relieved, therefore, to learn that there is plenty of evidence to support the contention that dairy heifers **should** be generously fed, to permit maximum growth and development.

In the October issue of "Hoard's Dairyman," Dr. R. S. Adams quotes a series of figures which show that big, well-fed heifers make the most productive cows. Careful measurements have been made in a series of officially-tested herds. These all show that the retarded growth associated with restricted feeding seriously reduces the life-time returns obtained from the cows. In those herds in which the growth rates of the calves were standard or above standard, the average production of butterfat **by the whole herd** was 50 lb. better than in herds where the growth rates of the calves were below standard. With butterfat at 4s. per pound such a difference amounts to £10 per cow per annum.

The results obtained from thousands of two-year old cows have likewise been analysed. These show clearly that the **big** heifers are the best, no matter what the breed. In other words, calves which have been heavily fed to permit maximum growth become the most profitable cows. It is of value to quote the results reported from the U.S.A. for highly productive Guernsey and Friesian herds. All the figures have been adjusted to Mature Cow Equivalents, so that the production averages appear rather overwhelming. The 3,000 Guernseys under consideration after adjustments averaged 807 gallons of milk and 391 lb. of butterfat in their first lactation. The 13,000 Friesians had an adjusted average of 1,186 gallons of milk and 446 lb. of butterfat.

In both breeds it is the small heifers which drag down the average. Among the Guernseys there were 25 per cent. which weighed between 800 and 900 lb. These averaged 368 lb. of butterfat. In contrast, the 22 per cent. which were somewhat heavier at 1,000 to 1,100 lb. liveweight, averaged 414 lb. butterfat. The 8 per cent. which were heavier again, averaged 442 lb. butterfat, or 74 lb. per head more than the heifers which weighed less than 900 lb. The same trend is seen in the Friesian breed. The 15 per cent. of heavy cows weighing between 1,200 and 1,300 lb. averaged 478 lb. butterfat, which is 70 lb. better than the 408 lb. produced by the 15 per cent. of so-called light-weights weighing between 900 and 1,000 lb.

These figures indicate very clearly that it pays handsomely to feed heifers so that they make maximum growth. Admittedly, with good feeding, cows which are undersized when first they freshen, may still

grow to reasonable size, and subsequently produce very well. But maximum production cannot be expected while such growth is taking place. It seems much more logical to make sure that this growth is made **before** calving, rather than have returns reduced because of growth during the initial lactation.

The lessons to be learnt from this American study are of considerable importance. In fact, the conclusions are so much as one would expect that one wonders why the vogue for underfeeding ever came into being. A possible explanation is that the effects of good feeding have become confused with the evils of delayed mating. Many stud-breeders believe that it is an advantage to delay mating until the heifer is well-developed. There is no doubt that, as a result, many well-grown heifers have been penalised. If **big** heifers are not mated, there is a definite possibility that nutrients which should be used for pregnancy and lactation will be diverted to the development of grossly overweight carcasses. It is not fair, however, to blame overfeeding for this undesirable consequence. The fault lies with the farmer who fails to exploit the rapid development which good feeding has permitted.

Fortunately, most breeders of livestock now realise that well-grown animals come to no harm if mated at an early age, **so long as they are well fed during lactation.** In fact, both cattle and sheep breeders now realise that there is much to be gained from early mating. The sooner that young stock can be brought into profit the better, providing that there is no reduction in life-time production. Certainly there is much to be gained and nothing to lose by having heifers calve at two years of age, rather than later.

In contrast, if feed intake is restricted so that the heifers remain lean, oestrus will be delayed, more services will be required for conception, and there is more likelihood that trouble will occur at calving time.

Most farmers take a delight in rearing sleek, healthy, well-fed animals. It should be a source of satisfaction, therefore, to be re-assured that well-bred heifers can come to no harm if generously fed on good quality feed, which will ensure the maximum rate of growth.

## HORSE LOSSES IN THE KIMBERLEYS

The Veterinary Branch of the Department of Agriculture, in association with the Government Botanist, has been carrying out investigations into horse losses on a number of West Kimberley properties.

The main reason for the work was to determine whether there were any indications that infectious equine anaemia was present in this State, following its diagnosis in Queensland.

These investigations were carried out on Gogo, Brooking Springs, Jubilee Downs and Millijiddee Stations. On Gogo there was a mortality of 20 horses in the 1958/59 wet season but after the river frontage area was fenced off no losses were experienced in the 1959/60 season.

Losses also occurred on Brooking Springs where the animals had access to considerable amounts of Crotalaria in 1959. However care was being taken this year to keep them out of the paddock where Crotalaria was plentiful.

On Jubilee Downs there were no abnormal losses but on Millijiddee there had been heavy losses and many of the wet mares and foals on the property were in poor condition.

The investigations failed to provide any evidence that infectious equine anaemia was present in the West Kimberley area. Losses appeared to have been caused by plants responsible for liver damage, mainly Crotalaria but possibly in some cases Indigophera (which causes "Birdsville Disease"). Heavy parasitic infestation, associated with poor nutritional conditions during the dry season, had contributed to the mortality.

# Some Factors Affecting the Baking Quality in Wheat

By A. R. EGAN, B.Sc. (Agric.), Adviser, Cereal Laboratory

**ALTHOUGH between 10 per cent. and 15 per cent. of wheat consumed in Australia is used in feed for domestic animals, the primary usage in home consumption is for bread-making. Exports, which account for roughly 75 per cent. of the normal Australian crop, are also mainly used in bread-making.**

For this reason it is on the basis of the nature of the loaf produced that wheat quality is commonly assessed.

Baking quality is controlled by conditions on the farm, including choice of variety, and very little can be done to improve this characteristic except by the farmer, whose attitude must largely be governed by what the market demands and is willing to pay for.

According to general agreement among authorities, an overall improvement of quality in our wheat will improve its saleability.

To appreciate the extent to which the farmer can improve the quality of the wheat which he produces, some knowledge of factors affecting wheat quality is necessary.

Baking quality is, by and large, determined by the protein of the grain. Two aspects of protein are important in the overall consideration. These are the **quantity** of protein present in the grain (usually represented as protein percentage) and the **quality** of this protein. These two characteristics are somewhat differently controlled.

The quality of the protein is almost exclusively determined by the variety of wheat grown and it is this aspect which gives different varieties their varying reputations for quality. Because of this we can speak of "good quality," or "semi-hard" or "strong" varieties such as Gabo, Eureka and Wongoondy, and "weak" or "soft" varieties, such as Bencubbin Insignia and so on.

Quite early in the history of investigations on baking quality it was found that samples of grain with the highest protein content did not necessarily give the best loaf, but that certain varieties always gave a better loaf than others at the same protein content. Thus the idea of protein quality and its relationship to variety arose. High protein quantity will not make up for poor protein quality, but on the other hand, good quality characteristics of the variety will not cancel out the effect of very low protein percentage. The grain from good quality varieties grown under conditions which result in low protein percentage, are mottled and undesirable because of poor milling and baking behaviour.

Varieties show very little control over protein percentage, the only effect being insofar as maturity characteristics and such factors as drought resistance fit in with the effects of climate.

On the other hand, factors which affect the quantity of protein in the grain have very little influence, if any, over the quality of protein.

The factors concerned in the determination of protein percentage are thus external to the plant, or environmental, and include climate, soil moisture relations, and soil fertility, particularly the aspect of nitrogen in the soil and its availability to the growing and maturing plant. These environmental factors determine how much nitrogen goes into the grain as protein and to what extent this protein is diluted in the grain with starch.

## CLIMATE

Climate, as such, is not a factor which can be controlled by the farmer, but it is

possible to alter its effects by changes of rotational practices, and cultural operations, and by choice of varieties whose growth cycle is most likely to fit in with the expected season insofar as length of time to maturity is concerned. A variety which leads the maturing phase of the plant into a period where moisture is deficient results in "pinching" of the grain, with higher protein percentage because of lower starch content. Late planting can have the same effect. With knowledge of these effects, it is possible to partially avoid the more adverse effects of unfavourable climates with respect to both yield and protein content.

A long, slow ripening period favours high yield (provided there is no interference from disease) and, unless nitrogen is readily available during this period there is a lowering of protein percentage. Thus the effects of such a season can be offset by raising the fertility of the soil with respect to nitrogen. This is achieved where legume-pastures figure in the rotation system. More will be said about this later.

Areas with shorter growing seasons, and shorter ripening periods produce grain of higher protein percentage, associated usually with lower yield than is experienced in the wetter and longer seasoned areas. In efforts to increase yield, high protein content will be maintained provided soil fertility is kept at a high level with respect to available nitrogen.

Other aspects of climate cannot be affected by farmers' activities very readily, and consequently a close study of conditions as they exist now has been undertaken in our recent investigations in order to examine the variations from year to year in the distribution of grain of differing protein content over the State. High protein wheat is produced in the drier northern and north-eastern wheat-belt areas. Coming southward and westwards, as a general rule the longer the growing season, the lower the protein percentage. It is possible to produce some high protein wheat over a wide area of Western Australia, but this class of grain represents a decreasing proportion of deliveries to the railway sidings as rainfall increases. At any siding, the same variety produces grain with a wide range of protein percentages. For example in one year, at Coorow, the variety Wongoondy had protein percentage varying from 6.9 to 12.6 per cent.; while for the variety Gabo at Lake Grace the range was 7.8 to 12.1 per cent. This is due to either soil conditions and fertility, or to such factors as dates of planting.

## SOIL CONDITIONS

While the farmer can only partially avoid the more adverse effects of climate, he can exercise a measure of direct control over the soil conditions on his farm.

Western Australian soils are notoriously poor in fertility, perhaps more so in the wetter areas than in the drier areas. This infertility extends to the available nitrogen status as well as the well known phosphate and trace element deficiencies.

For this reason it is necessary to make use of fertility boosting practices.

Wheat yields in Western Australia are so greatly affected by phosphate application, and also by use of trace elements in certain areas that fertilisation of the soil with these plant nutrients is a general practice. The deficiency in nitrogen could also be overcome by the use of nitrogen fertilisers, such as sulphate of ammonia, or urea form, but the economics of such a practice are at present in doubt. Nitrogen applied to the soil early in the growing season boosts plant growth, and, provided moisture is available as required, allows big yield increases. Later applications may boost yield, but can cause the plant to die if applied too late, or too heavily. Lack of soil moisture causes nitrogen fertiliser to produce lower yields.

Unless the season has adverse effects on yield, the protein percentage of the grain is likely to be little affected by early application of nitrogen, until high levels of nitrogen are used.

Late applications of nitrogen should increase protein percentage but often have small effect on the yield.

Increase in protein percentage without increase in yield is at the present unrewarding, and as a consequence it is desirable to increase protein percentage more or less as an incidental to increasing yield. Slow release of nitrogen continuing throughout the season appears to be the answer, and organic matter is the best such source. Clover or other leguminous pasture plants which take up nitrogen from the air are a method of adding to the soil fertility

in this way, and ley-farming systems incorporating these have been shown to increase both yield and protein percentage of wheat. This method is simple and practical, whereas at the present nitrogen fertilisation is rather a complicated question from the economics standpoint of its effect on yield and has different effects on protein percentage depending on the time and method of application, and the chemical nature of the fertiliser used.

**TO SUMMARISE**

(1) Baking quality is dependent upon both the quantity and the quality of protein present in the grain.

(2) The quality of protein depends mainly upon variety. Environmental influence is small.

(3) The quantity of protein and its relationship to yield, or more directly starch dilution in the grain, is mainly an environmentally controlled factor. Such aspects as rainfall, and its distribution throughout the season, and soil fertility from the nitrogen point of view are probably the most important features. Smaller variations are caused by factors such as time of planting, variety used and methods of cultivation.

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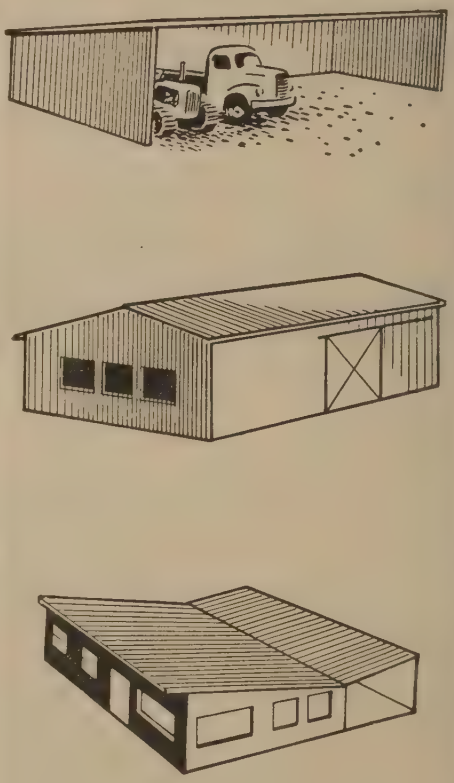

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# Rats & Mice AND THEIR CONTROL

By C. D. GOODING and J. L. LONG

**BEFORE colonisation by the white man, Australia contained over 50 species of rats and mice. Although several of these native species have been known to breed to plague proportions they are normally slower breeders than the introduced species. Once settlement had been established on our shores it was only a matter of time before the introduction of more of these pests, occurred probably from the British Isles.**

These, owing to their long association with man, had become omnivorous and therefore represented a greater menace to health and commerce than their native relatives. As far as is known to date, two species of rat and the common house mouse have been introduced into Western Australia. These are the only species existing in large numbers, and it is towards them that most control measures are directed.

## THE SEWER RAT

*(Rattus norvegicus.)*

The Norway or sewer rat, which originated in China spread to Great Britain in the early or middle 18th Century. It is usually found in the environs of cities and coastal ports and waterways.

It is in urban surroundings that it finds the most extraordinary number of different habitats in which to live and these include dwellings, backyards, refuse dumps,

Fig. 1.—The Norway or Sewer Rat. Note the blunt nose, short ears and tail not exceeding the length of the head and body

shops, restaurants, hotels, offices, warehouses, granaries, etc. The sewer rat is found living in a variety of temperature conditions varying from warm in brickworks, etc., to the low temperatures of cold stores.

Although occurring in company with the slighter and more timid ship rat, there appears to be some competition between the two species. The sewer rat, although a reasonably good climber is less frequently found on ships, preferring to live under floors or in drains about dwellings and is often seen along the banks of the Swan River at night. It is a sturdily built animal with large strong feet, short ears and a short thick, coarsely-scaled tail which is shorter than the head and body combined.

An adult specimen commonly has a body weight of 1 lb. and a body length (exclusive of the tail) of about 11 in. Much larger specimens are frequently encountered.

Fig. 2.—The Roof Rat. This species has a slender snout, large hairless ears and a long slender tail which is usually longer than the head and body combined

### THE ROOF RAT
*(Rattus rattus.)*

The ship rat or roof rat came originally from India, colonising Europe in the early Middle Ages and is identified by a slender tail which is invariably longer than the head and body. The large leafy ears and shorter, sleeker hair will usually distinguish this species from the sewer rat. Fully grown, this rat seldom weighs more than ½ lb. with a body length of from 8 to 10 in. Unlike the sewer rat this species is well-distributed throughout Australia, excepting possibly sub-desert and extremely inhospitable coastal regions, and occurs as a field, foliage and house-infesting animal. The roof rat is so-called because of its ability to climb and live in high localities such as grain silos and the top floors of warehouses. Its damage is primarily to food and it is the species most likely to introduce bubonic plague because of its ship-borne habits.

### THE COMMON HOUSE MOUSE
*(Mus musculus.)*

The house mouse has been in Britain, Europe and Northern Asia since prehistoric times and, once introduced into Australia, it soon "took to the bush" and is now geographically widespread. Many people imagine that there are two different species, a house mouse and a field mouse, but they are one and the same animal. (The native species rarely attain plague proportions and have seldom been seen in large numbers in recent years). Although there is considerable size and colour variation in the house mouse they are easily distinguished from the mice-like indigenous species. In the introduced mouse (*Mus musculus*) a well-marked notch or ledge can be seen behind the tips of the upper teeth into which the lower teeth fit, the same notch not being visible in any of the allied native forms. The full-grown mouse seldom weighs more than 1 oz. and is 3 to 4 in. in head and body length with a tail of from 3 to 3½ in. long. The ears and eyes are small and the tail is scantily clad. The upper surface of the body is almost

Fig. 3.—The Common House Mouse

uniformly grey-brown and the underparts buff-grey to whitish. Mice live in any structure they can enter which offers some protection and within range of food, and can pass through a hole ½ in. square. Where food is plentiful the daily range of mice is quite small.

## BREEDING HABITS

The average number of young per litter in the rat is ten, from six to 22 being a normal variation. From three to 12 litters can be produced in the one year. The young are blind at birth but rapidly develop and breed when three to four months old. The life-span of the rat is much longer than that of the mouse and varies between three and five years. As many as seven litters in seven months from a single pair have been recorded, the gestation period being only 21 to 25 days. The rat's tremendous reproduction potential—the progeny from one pair could, under the most favourable conditions, exceed 350,000,000 in three years—and its rapid development indicate the ability to recuperate quickly from any unusual depletion in numbers. Therefore the rat can increase to plague proportions quickly in favourable circumstances. It shows us too how persistent man's resistance must be to this pest if it is to be kept under control. In the U.S.A. the rat population has been estimated to approximate the human population.

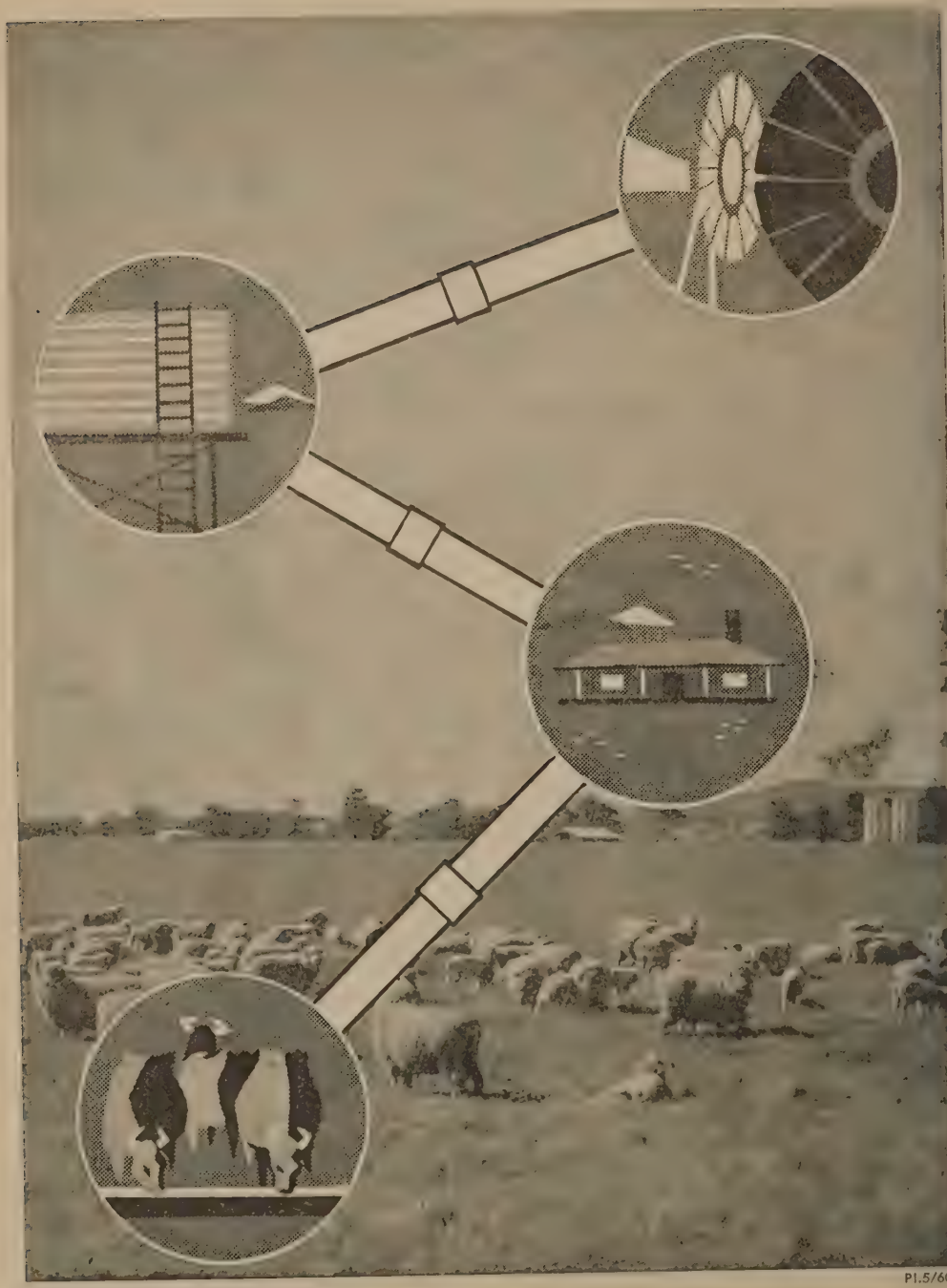
The house mouse averages some five to six young per litter, the young being able to run about when only 21 days old and can breed at 42 days of age. Individual captive mice have produced 100 young per year. The species is relatively short-lived, most individuals probably not living longer than 12 months, hence the population "turnover" is very rapid.

## HEALTH HAZARDS

Because of their close relationships to man and domestic animals and because of their scavenging habit, living on both filth and edible foods, it is not surprising that rats and mice play an extremely important part in the spread and dissemination of disease. Quite a number of their own diseases are transmissable to man and domestic animals. Mice sometimes carry Salmonella bacteria that can kill man and because of their greater penetration into buildings are probably as big a health hazard as their larger rat relations. Such diseases as bubonic plague, typhus fever, spirochetal jaundice, rat-bite fever, tularemia, trichinosis, rabies and food poisoning can be carried and spread by these pests.

## CONTROL METHODS

The principal methods of controlling rats and mice are (1) exclusion (2) poisoned baits (3) poisonous gases or dusts (4) traps. Various other measures have been tried, but many are of little use. Exclusion is probably the real solution and all other methods will give only temporary relief.



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**Exclusion.**

Can only be effectively performed while a building is in construction, but much work towards this end can be carried out after construction in blocking holes and fitting mesh and metal sheeting around holes where pipes and conduits pass through walls, etc. Exclusion of rats and mice from premises means leaving no opening more than $\frac{3}{8}$ in. in width into a building or other enclosure and protecting all food supplies from these animals. Long and elaborate methods of proofing against these pests could be explained but would differ with conditions of the building and location of such areas.

Sound concrete floors with a thin L-shaped concrete foot on the foundation wall will prevent rats from burrowing into buildings. Doors and windows need to be tight-fitting and, if of timber, they should be sheathed along the ground level with 18-gauge galvanised sheet metal at least 12 in. high and reaching down within $\frac{3}{8}$ in. of the floor.

In practice, exclusion of rodents requires:—

(1) Concrete floors and exterior curtain walls around foundations.

(2) Solid exterior walls with no holes or large cracks.

(3) Elevation of small buildings 12 to 18 in. above ground.

(4) Screens over all openings, both at the ground level and above. These should be of $\frac{1}{8}$ or $\frac{1}{4}$ in. mesh, or metal grille.

(5) Cement or metal sheathing around all holes where pipes or conduits pass through walls.

(6) Tight-fitting doors and window screens.

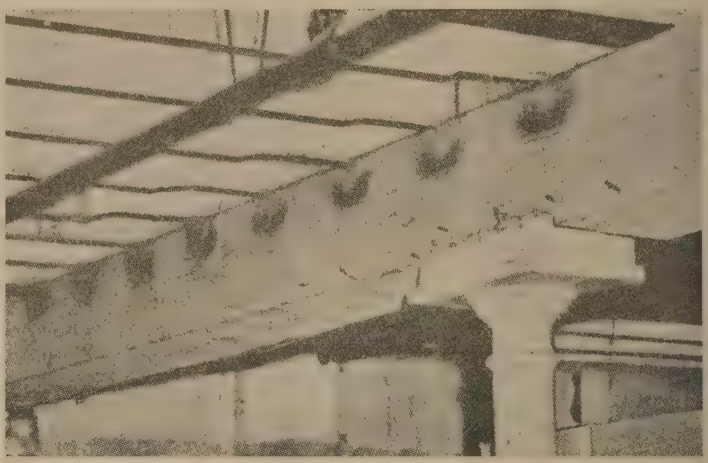

Fig. 4.—Smears made by rats travelling along a supporting floor beam. The rats must crawl along the sides of the beam under each joist and leave the U-shaped markings.

*Exclusion from Haystacks and Silos.*

The exclusion of rats and mice from haystacks and silos should be carried out in exactly the same way as exclusion from a building. However, as haystacks are hardly ever built on concrete floors, other precautions become necessary. For many years some farmers have been building haystacks and storing grain up on platforms 18 in. high or enclosing them with a mouse-proof fence made of flat galvanised iron. This is made by taking 3 ft. wide sheets of iron, bending the top 6 in. outwards and downwards at an angle of 45°. The bottom 6 in. is bent outwards in a right angle and buried 6 in. into the ground. This gives a fence 18 in. high with top and bottom projections. Sheets should be overlapped at least 2 in. where jointing. Unless mice are already present in the produce when it is stored within a fence such as this, it will remain mouse-free indefinitely.

*Harbourage.*

Old machinery, rubbish heaps, timber piles, weed growth and general litter all

Fig. 5.—The right and wrong ways of rubbish disposal. Open bins and heaps of garbage (top) attract rats and mice. In the lower picture, the bins are in brick recesses with screened doors on spring hinges. Rats, mice and flies are kept out

provide the shelter necessary for rats and mice to live and breed in. Bags of grain, timber and other goods should be neatly stacked to permit regular inspections and control measures. Garbage, if not burned immediately, should be stored in rat-proof metal bins until it can be destroyed. Mice can live on about $\frac{1}{8}$ oz. of food per day and rats on about 1 oz. Therefore it is necessary to clean up spillage and food material however small the quantity.

**Poisoning.**

The chief method of routine control by most pest control operators is the use of poison food or baits. The extent of the rat or mouse infestation should at first be determined by looking for droppings, body smears, footmarks, damage or burrows and then the whole area baited at the one time. Poisons may be bought ready mixed with bait materials or as concentrates which can be incorporated with wheat, rolled oats, fresh meat, fish, apples, carrots and other vegetables.

Commercially-prepared bait materials available in Western Australia include baits containing warfarin, strychnine, phosphorus, red squills and antu. Those containing warfarin are probably the best rat and mouse killers available at present and are sold under various trade names

and all contain 0.025 per cent. warfarin. (Warfarin is also obtainable in concentrated form for mixing with any suitable carrier. This can be mixed with 20 times its own weight). Strychnine baits are obtainable in two concentrations 0.16 per cent. and 0.3 per cent. and are fairly successful in controlling mice but can usually only be used once as their reacceptance following a poisoning is very poor. Strychnine is normally objectionable to rats and therefore is rarely used in preference to the anti-coagulants (warfarin, etc.). Zinc phosphide is also available as a concentrate to mix with a selected bait material but has a strong odour and taste, and is not always successful. **Free feeding is advisable for rat control with all baits other than those containing warfarin.** Before selecting a baiting material to poison it is advisable to make tests with grain (whole or crushed), fruit, vegetables and other substances to see which is preferred. This applies particularly when poisoning rats, as their desire for food is often governed by the material upon which they have been feeding.

Poison bait can be placed in burrows and holes, infested areas under buildings or in crevices and cracks, about foundations and walls and on the floors and rafters along runways used by the rats and mice. To avoid excess spillage, bait placed on small sheets of paper or shallow tins will suffice. It is important however to distribute sufficient poison bait so that all rats and mice have access to one or more baiting stations. From 2 to 4 oz. of poisoned bait per station is usually sufficient for moderate rat and mice infestations provided the stations are regularly replenished, particularly if using materials containing warfarin. Rats and mice must feed on warfarin bait for a number of successive days before acquiring sufficient to produce death.

On farms, poison bait should be laid preferably under shelter, behind stacks, beneath flooring, in piles of timber or in old pipes, etc., whilst rafters and other high places near the tops of bag stacks should not be neglected.

Used as a poisonous dust, sodium fluorosilicate is spread on floors where rats and mice run. Some of the dust gets on to their hair and feet, proves irritating, and is licked off and swallowed. The rodents die in three to six days. This chemical must not be used where it might contaminate food or be swept up with grain for domestic animals.

Baits should at all times be placed in or on a container in a sheltered situation where there is the least possible danger to children and domestic animals. Anticoagulant poisons such as warfarin are relatively safe, as a single, even very large dose is not toxic.

No known kind of bait has proved effective under all circumstances and a change in the kind of poison bait from time to time is most desirable. The importance of measures designed to restrict the food of rats and mice should not be overlooked. Food shortage naturally reduces the number of rats and mice in any locality and tends to limit the rate of increase. Hungry rats are much more easily destroyed by traps and poisons.

*Poison Baiting on the Farm.*

As yet there is no really effective, cheap method of baiting rats and mice on a field scale. Field baiting has been done successfully in England and America but only on a very small scale. Baiting stations consisting of a container to hold the poisoned grain were established and after a successful "free feeding" period poison was introduced. As the feeding range of rats and mice is very limited, especially when food is plentiful, the number of stations required to cover a whole farm would be tremendous. If stock were excluded, a poison furrow could be used much the same as in rabbit poisoning, excepting that strychnine or warfarin would be the poisons of choice. If using warfarin, free feeding would not be necessary but the poison would have to be supplied for at least a week. A lot of furrow would be required to cover a property as the feeding range of the animals is restricted. The concentrated warfarin would be the most convenient way to purchase, as the farmer could then make up the bait as required. This concentrate is obtainable from local pest control operators.

Water poisoning during summer months is another possible way of reducing numbers of rats and mice on a farm, but this would also have to be applied through baiting stations and would be a costly and

laborious method. A water-soluble warfarin derivative would be the poison of choice.

**Fumigation.**

Many rats in burrows, or hidden in ships and buildings, in hay stacks, poultry sheds, store rooms and other enclosures, can be killed by means of poisonous gases where baiting and trapping may not be as equally effective. Baiting and trapping however should follow to remove rats and mice in the surrounding area. All the fumigants in use however are highly poisonous to man and domestic animals and suitable respirators should be worn.

Calcium cyanide can be used and is available in both dust and granular form. The dust is applied with a pump into burrows and holes, the entrances of which are afterwards closed. When using granular cyanide, place 1 tablespoon (1 oz.) of the material 6 to 8 in. inside the burrow with a long-handled spoon and block the entrance tightly, taking care that the cyanide is not covered.

Methyl bromide, one of the most penetrating and effective of the commercially available gases is used to kill rats at the rate of 4 oz. per 1,000 cubic feet. Special equipment is necessary however, in the way of a plastic sheet to cover the area to be treated. Carbon monoxide from an automobile or tractor exhaust may be forced through a hose into rat burrows. Unlike some other gases, carbon monoxide remains in a burrow for some time, not being absorbed by the soil or soil water, hence it has a long period of effectiveness. Chloropicrin ("Larvacide") is a volatile material with a very pungent smell and is used at the rate of 4 lb. per 1,000 square ft. of floor area.

*Fumigation of Haystacks and Silos.*

Poisoning in haystacks and silos has always been most difficult because of the abundance of feed available to the pests. If exclusion is not practical, then the only other way to deal with the problem is by the use of fumigation. Chloropicrin is most useful if the farmer wishes to carry out the work himself. The method consists of placing the liquid some few feet down into the haystack through a length of water pipe (or of breaking the ampoules in the stack through a length of pipe). The gas is heavier than air and will gradually penetrate into the very bottom of the stack. A 1-pint bottle should be enough to fumigate a normal sized haystack.

**Fig. 6.—Two stages in the sheeting of a haystack preparatory to fumigation**

Some of the pest control operators have recently begun a fumigation service to landholders. Large plastic sheets are spread over the haystack or grain stack and fumigation carried out. Details of costs, etc., can be obtained from the operators concerned.

**Trapping.**

Trapping is the preferred method of control in homes and office buildings, because animals killed in this way may be easily removed, whereas poisoned rodents may die within walls or in other inaccessible places and create bad odours. Almost any traps will catch some rats, but long experience proves that the

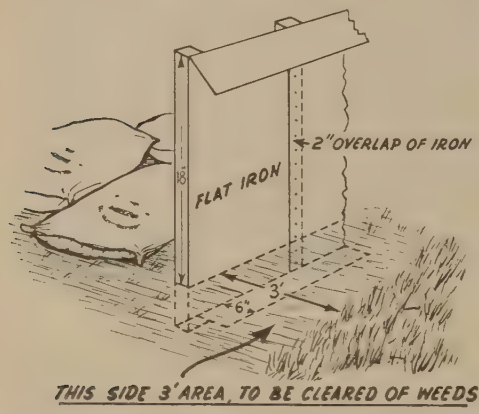


Fig. 7.—A mouse-proof fence will protect haystacks of bagged grain (see text)

ordinary spring snap trap is best and cheapest. Results from trapping depend more on the numbers of traps used and on the way in which they are placed than on the type of traps used.

Human odour from the handling of traps will not keep rats and mice away from them. It is important, however, to keep traps in good working order so that they are relatively "hair-triggered." For trapping house mice in buildings, place traps along the wall in regular runways with the trigger end towards the baseboard, at intervals of two to three feet, according to the infestation. Rolled oats are almost always effective but cheese is not.

Rats are considered somewhat "wiser" than mice, yet many can be taken with wooden snap traps. If traps are set and baited at once, some rats will be caught. However, better results will be had if the traps are placed and baited, but left unset for three to five nights before being baited and set. This overcomes the rat's fear of new and strange objects. Rats that ignore an exposed trap will often be caught if a board or box is placed to shield the trap, leaving a space for them to enter and for the trap spring to operate.

A variety of baits, such as meat, vegetables and cereals should be used on successive traps for best results and bait should be changed regularly and not left on the trap when stale. Alternative attractive baits are cooked meat, bacon, fish, apple, melon, tomato, carrot and nut meats. Almost any food suitable for human consumption will appeal to the gluttonous appetite of rats and mice, so that there should be no lack of variety.

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# *The use of . . .*

# SEED INOCULUM FOR SUBTERRANEAN CLOVER

## *in the*

## *Jerramungup, Gairdner River Areas*

By W. J. TOMS, B.Sc. (Agric.) Research Officer, Plant Research Division

**IT is unlikely that benefits will be obtained from inoculating Dwalganup or Bacchus Marsh subterranean clover seed sown in the Jerramungup or Gairdner River districts other than on the fine sands of different geological origin (Miocene) occurring in some southern areas of the Gairdner River District.**

In Western Australia it is common practice to inoculate the seed of subterranean clover prior to seeding. In many cases it is known that response to inoculation is very unlikely, yet it is felt that it is insurance against a complete failure. Sometimes farmers inoculate seed used to reseed cropped paddocks that had previously grown good subterranean clover stands. Seed inoculation is not necessary in these cases.

If it is necessary to inoculate seed, evidence suggests that lime pelleting (1) is also an advantage, especially if dry conditions follow seeding (Fitzpatrick, Cass Smith, private communication).

The cost of labour and materials for pelleting and inoculating sub. clover seed is roughly 2s. 6d. an acre. In terms of total cost of establishing sub. clover on new land this cost is not great. However it has been demonstrated in some areas that this expenditure is of no benefit.

Results, both from experiments and from War Service Land Settlement bulk sowings, so far indicate that it is not necessary to inoculate seed to be sown on the majority of soils in the Jerramungup, Gairdner River areas.

However, in the southern portion of the Gairdner River project, there are areas of fine sand of Miocene origin varying in depth from a few inches to many feet. In general, these areas occur south of Swamp Road. Experimental work has shown that seed inoculation is essential when planting sub. clover on this type of soil.

On the deep sand ridges, satisfactory establishment of sub. clover has not been obtained—regardless of treatment. It is recommended that this plant should not be sown on such areas.

Off the sand ridges, in areas where fine white sand up to a depth of 3 ft. overlies clay or consolidated ironstone, good stands of sub. clover are obtained with inoculated seed. The clay or ironstone holds up the water in these soils and their higher moisture level is probably the reason for the better clover growth on them compared with that obtained on the ridges. Yields from first year stands on these soils are trebled by the use of inoculum.

If no inoculum is used, good stands of sub. clover are not obtained until the third season.

### SUMMARY

(1) Seed planted on fine-textured sandy soils, mainly occurring south of Swamp Road, must be inoculated.

(2) Sub. clover should not be planted on the deep sand ridges.
(3) It appears unlikely that responses to seed inoculum will be obtained in the Jerramungup or Gairdner River areas other than on the soils mentioned in 1 above.
(4) After cropping, it is not necessary to inoculate seed used to reseed paddocks that had previously grown good stands of clover.

**REFERENCE**

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# DISEASES RECORDED

## ON

# CEREALS, GRASSES

## AND

# PASTURE LEGUMES

## IN

# *Western Australia*

Compiled from Departmental Records by by S. C. CHAMBERS, M.Sc., Plant Pathologist

**THIS list constitutes a revision of portion of the census published by Carne (1925) and supplemented by the same author in 1927. It also contains records of diseases identified in the period between these earlier publications and December 31, 1959.**

**The list is divided into two sections, the first dealing with pasture legumes and the second with cereals and grasses. The sections are arranged alphabetically according to the botanical names of the host plants. In general, the viral, bacterial, fungal and nematodal diseases and physiological disorders are listed in that order. The locality and date of the first record in each instance, is also given whenever possible.**

**A list of common names of host plants has been appended to facilitate reference.**

| Host | Cause | Common Name | FIRST RECORD | | |
|---|---|---|---|---|---|
| | | | Place | Month | Year |
| LEGUMES | | | | | |
| *Lathyrus tingitanus* L. .... (Tangier Pea) | **Pea Mosaic Virus* Doolittle et Jones .... | Pea Mosaic .... .... | Gingin .... .... | .... | 1941 |
| *Lupinus alba* L. .... (White Lupin) | **Pea Mosaic Virus* Doolittle et Jones .... | Pea Mosaic .... .... | Nedlands .... | October | 1939 |
| | *Pleospora sp.* .... .... .... .... | Leaf Spot .... .... | Nedlands .... | .... | 1941 |
| *Lupinus angustifolius* L. (N.Z. Blue Lupin) | *Bean Yellow Mosaic Virus* .... .... | Bean Yellow Mosaic | Kelmscott .... | September | 1954 |
| | **Pea Mosaic Virus* Doolittle et Jones .... | Pea Mosaic .... .... | Nedlands .... | October | 1939 |
| | *Ascochyta sp.* .... .... .... .... | Ascochyta Stem Rot | Pick. Brook .... | August | 1940 |
| | *Botrytis sp.* .... .... .... .... .... | Botrytis Stem Rot .... | Carmel .... .... | .... | 1941 |
| | *Ceratophorum setosum* Kirchn. .... .... | Leaf Spot .... .... | Manjimup .... | .... | 1941 |
| | *Sclerotinia sclerotiorum* (Lib.) deBy .... | Stem Rot .... .... | Pick. Brook .... | .... | 1940–41 |
| *Lupinus digitatus* Forsk. (W.A. Blue Lupin) | *Bean Yellow Mosaic Virus* .... .... | Bean Yellow Mosaic | Upper Swan .... | August | 1954 |
| | **Pea Mosaic Virus* Doolittle et Jones .... | Pea Mosaic .... .... | Nedlands .... | August | 1939 |
| | *Erysiphe polygoni* DC. .... .... .... | Powdery Mildew .... | Balcatta .... | October | 1959 |
| | *Fuligo septica* Gemelin .... .... .... | Slime Mould .... .... | E. Chapman .... | February | 1958 |
| | *Phoma sp.* .... .... .... .... .... | Stem Rot .... .... | Busselton .... | .... .... | 1937–38 |
| | *Sclerotinia minor* Jagger .... .... .... | Stem Rot .... .... | Northam .... | September | 1956 |
| | *Sclerotinia sclerotiorum* (Lib.) deBy. .... | Stem Rot .... .... | Chapman .... | August | 1931 |
| *Lupinus luteus* L. .... (Yellow Lupin) | *Bean Yellow Mosaic Virus* .... .... | Bean Yellow Mosaic | Kelmscott .... | July .... | 1954 |
| | **Pea Mosaic Virus* Doolittle et Jones .... | Pea Mosaic .... .... | Nedlands .... | October | 1939 |
| | *Ceratophorum setosum* Kirchn. .... .... | Leaf Spot .... .... | Boyup Brook .... | October | 1959 |

* Norris (1943).

## Diseases Recorded on Cereals, Grasses and Pasture Legumes in Western Australia—continued

| Host | Cause | Common Name | FIRST RECORD | | |
|---|---|---|---|---|---|
| | | | Place | Month | Year |
| LEGUMES—*continued* | | | | | |
| *Medicago denticulata* Willd. (Burr Medic) | *Bean Yellow Mosaic Virus* | Bean Yellow Mosaic | Perth | June | 1954 |
| | **Pea Mosaic Virus* Doolittle et Jones | Pea Mosaic | ... | ... | 1941 |
| | *Pseudopeziza medicaginis* (Lib.) Sacc. | Leaf Spot | Northam | August | 1923 |
| | *Uromyces striatus* Schroet. | Rust | Balingup | July | 1955 |
| *Medicago sativa* L. (Lucerne) | *Lucerne Witches' Broom Virus* Edwards | Witches' Broom | Carnarvon | April | 1954 |
| | *Ascochyta ? imperfecta* Pk. | Black Stem / Leaf Spot | South Perth | April | 1925 |
| | *Fusarium sp.* | Damping Off | Bramley | October | 1958 |
| | *Helicobasidium purpureum* (Tul.) Pat. | Violet Root Rot | Bickley | August | 1923 |
| | *Macrophomina phaseoli* (Maub.) Ashby | Root Rot | Mid. Junct. | January | 1925 |
| | *Peronospora trifoliorum* de Bary | Downy Mildew | Cottesloe | ... | 1931–32 |
| | *Pleospora herbarum* (Fr.) Rabenh. | Leaf Spot | South Perth | June | 1927 |
| | *Pseudopeziza medicaginis* (Lib.) Sacc. | Common Leaf Spot | Bickley | August | 1923 |
| | *Sclerotinia ? trifoliorum* Eriks. | Crown and Stem Rot | Carnamah | July | 1940 |
| | *Uromyces striatus* Schroet. | Rust | Victoria Park | September | 1924 |
| | Fungus Not Recorded | Slime Mould | Geraldton | February | 1958 |
| *Medicago scutellata* Mill. (Snail Clover) | *Uromyces striatus* Schroet. | Rust | Morawa | September | 1958 |
| *Medicago tribuloides* Desr. (Barrel Medic) | *Rhizoctonia sp.* | Root Rot | Geraldton | July | 1957 |
| *Melilotus indica* (L.) All. (King Island Melilot) | *Pea Mosaic Virus* Doolittle et Jones | Pea Mosaic | Balcatta | November | 1954 |
| *Pisum arvense* L. (Field Peas) | *Pseudomonas pisi* Sackett | Bacterial Blight | Boyup Brook | ... | 1942 |
| | *Ascochyta pisi* Lib. | Black Spot | Darling Range | August | 1956 |
| *Trifolium cernuum* Brot. (Drooping Flowered Clover) | *Uromyces trifolii* (Hedw. F.) Lev. | Rust | Duranillin | October | 1943 |
| *Trifolium fragiferum* L. (Strawberry Clover) | *Pleospora herbarum* (Fr.) Rabenh. | Leaf Spot | Nolba | December | 1958 |
| | *Pseudopeziza trifolii* (Fr.) Fckl. | Clover Leaf Spot | Denmark | October | 1957 |
| | *Pseudoplea trifolii* (Rostr.) Petr. | Pepper Spot | Nolba | December | 1958 |
| | *Meloidogyne sp.* | Root Knot Eelworm | Esperance | January | 1959 |
| *Trifolium pratense* L. (Red Clover) | *Pea Mosaic Virus* Doolittle et Jones | Red Clover Mosaic | Mandogalup | May | 1959 |
| *Trifolium repens* L. (White Clover) | *Ditylenchus dipsaci* Kuehn. | Stem Eelworm | Boyanup | March | 1959 |
| | *Meloidogyne javanica* (Treub.) Chitwood | Root Knot Eelworm | Bunbury | December | 1954 |
| | Pathogen Not Recorded | Damping Off | Waterloo | January | 1955 |
| *Trifolium subterraneum* L. (Subterranean Clover) | *Bean Yellow Mosaic Virus* | Bean Yellow Mosaic | Perth | June | 1954 |
| | **Pea Mosaic Virus* Doolittle et Jones | Pea Mosaic | Gingin | ... | 1941 |
| | *Subterranean Clover Stunt Virus* Grylls et Butler | Stunt Virus | Esperance | August | 1958 |
| | *Ascochyta sp.* | Little Leaf / Stem Rot / Leaf Spot | Esperance | September | 1955 |
| | *Erysiphe polygoni* DC. | Powdery Mildew | Perth | December | 1952 |
| | *Fusarium sp.* | Seed Spotting | Esperance | May | 1956 |
| | *Physoderma trifolii* (Passer.) Karling | Wart Disease | Talbot Brook | December | 1955 |
| | *Pleospora herbarum* (Fr.) Rabenh. | Stem Spot | Kendenup | ... | 1936–37 |
| | *Pseudoplea trifolii* (Rostr.) Petr. | Pepper Spot | Balbarup | June | 1925 |
| | *Rhizoctonia solani* Kühn | Purple Patch | Geraldton | July | 1957 |
| | *†Uromyces trifolii* (Hedw. F.) Lev. *subterranei* Latter | Rust | Brunswick | September | 1928 |
| | *Meloidogyne hapla* Chitwood | Root Knot Eelworm | Witchcliffe | October | 1959 |
| | *Meloidogyne javanica* (Treub.) Chitwood | Root Knot Eelworm | Upper Swan | July | 1955 |
| | *Radopholus sp.* | Eelworm | Wongan Hills | August | 1958 |
| | *Cuscuta epithymum* L. | Dodder | ... | ... | 1924–25 |
| | Pathogen Not Recorded | Fairy Rings | New Norcia | June | 1943 |
| | Pathogen Not Recorded | Root Rot | Nedlands | August | 1959 |
| *Trifolium tomentosum* L. (Woolly Clover) | *Physoderma trifolii* (Passer.) Karling | Wart Disease | Namban | September | 1956 |
| *Vicia sativa* L. (Vetch) | *Botrytis cinerea* Fr. | Chocolate Spot | Kojonup | ... | 1950 |
| CEREALS & GRASSES | | | | | |
| *Agropyron distichum* Beauv. (Sea Wheat) | *Helminthosporium sativum* Pamm., King et Bakke | Leaf Spot | South Perth | July | 1959 |
| | *‡Puccinia graminis tritici* Eriks. et Henn. | Stem Rust | Mahomet's Fl. via Geraldton | March | 1958 |
| *Agropyron scabrum* (Labill.) Beauv. (Bearded Wheat Grass) | *§Puccinia graminis tritici* Eriks. et Henn. | Stem Rust | South Borden | ... | 1943 |

* Norris (1943).
† Identified as Races 5 and 6 by University of Sydney, N.S.W. in September, 1955.
‡ Races R. 126–1 and R. 222–5.
§ Race R. 126–1.

## Diseases Recorded on Cereals, Grasses and Pasture Legumes in Western Australia—continued

| Host | Cause | Common Name | FIRST RECORD | | |
|---|---|---|---|---|---|
| | | | Place | Month | Year |
| CEREALS AND GRASSES—*continued* | | | | | |
| *Agrostis stolonifera* L. (Bent Grass) | *Helminthosporium sp.* | Brown Patch | Metro. | | 1939 |
| | *Rhizoctonia sp.* | Brown Patch | Metro. | | 1939 |
| | *Sclerotinia homeocarpa* F. T. Bennett | Dollar Spot | Metro. | | 1939 |
| *Agrostis tenuis* Sibth. (Brown Top) | *Helminthosporium sp.* | Brown Patch | Metro. | | 1939 |
| | *Rhizoctonia sp.* | Brown Patch | Metro. | | 1939 |
| | *Sclerotinia homecarpa* F. T. Bennett | Dollar Spot | Metro. | | 1939 |
| | Non Parasitic | Heat Injury | Metro. | January | 1934 |
| *Agrostis sp.* | *Helminthosporium sp.* | | Fremantle | | 1936–37 |
| *Amphibromus Neesii* Steud. (Swamp Wallaby Grass) | *Puccinia graminis tritici* Eriks. et Henn. | Stem Rust | Boyup Brook | November | 1946 |
| *Aristida arenaria* Gaud. (Wind Grass) | *Sorosporium ? consanguineum* Ell. et Ev. | Smut | Isseka | January | 1959 |
| *Arrhenatherum elatius* (L.) Mert. et Koch. (False Oat Grass) | *Puccinia graminis* Pers. | Stem Rust | Wael | | 1943 |
| *Arrhenatherum elatius* (L.) Mert. et Koch. var. *Palaestinum* (Goiss) Bermn. | *Puccinia coronata* (Pers.) Cda. | Crown Rust | Kelmscott | | 1956 |
| *Arundo sp.* (Reed) | *Coniosporium inquinans* Dur. et Mont. | | | | 1895 |
| *Avena barbata* Brot. (Yatheroo Oats) | *Leptosphaeria avenaria* Weber | Septoria Leaf Spot | South Perth | July | 1927 |
| | *Puccinia coronata* (Pers.) Cda. | Crown Rust | Perth | November | 1925 |
| | | Leaf Rust | | | |
| *Avena fatua* L. (Black Oats) | *Erysiphe graminis* DC. | Powdery Mildew | | | 1924 |
| | *Leptosphaeria avenaria* Weber | Septoria Leaf Spot | | | 1924 |
| | *Mycosphaerella tulasnei* (Jancz.) Lindau. | Black Mould | | | 1924 |
| | *Puccinia coronata* (Pers.) Cda. | Crown Rust | Perth | October | 1923 |
| | | Leaf Rust | | | |
| | *Puccinia graminis avenae* Eriks. et Henn. | Stem Rust | Carnamah | September | 1927 |
| | *Ustilago avenae* (Pers.) Rostr. | Loose Smut | | | 1924 |
| *Avena sativa* L. (Oats) | *Pseudomonas coronafaciens* (Elliott) Stevens | Halo Blight | Dwarda | October | 1925 |
| | *Erysiphe graminis* DC. | Powdery Mildew | | | 1924 |
| | *Fusarium sp.* | Fusarium Blight | Peel Estate | August | 1924 |
| | *Leptosphaeria arenaria* Weber | Septoria Leaf Spot | Merredin | August | 1923 |
| | *Mycosphaerella tulasnei* (Jancz.) Lindau. | Black Mould | Perth | October | 1923 |
| | *Ophiobolus graminis* var. *avenae* Turner | Take All | Merredin | September | 1927 |
| | *Pleosphaeria semeniperda* Britt. et Adam. | Pleosphaeria Disease | Beverley | September | 1926 |
| | *Puccinia coronata* (Pers.) Cda. | Crown Rust | Guildford | July | 1923 |
| | | Leaf Rust | | | |
| | *Puccinia graminis avenae* Eriks. et Henn. | Stem Rust | | April | 1924 |
| | *Pyrenophora avenae* Ito et Kuribay | Helminthosporium Leaf Spot | Merredin | September | 1926 |
| | *Rhizoctonia solani* Kühn | Damping Off | Nabawa | June | 1957 |
| | *Scolecotrichum graminis avenae* Eriks. | Dry Blotch | Ballidu | June | 1956 |
| | *Ustilago avenae* (Pers.) Rostr. | Loose Smut | | | 1910 |
| | *Ustilago kolleri* Wille | Covered Smut | Kwelkan | September | 1923 |
| | *Ditylenchus dipsaci* Linnman | Cyst Eelworm | E. Beverley | August | 1958 |
| | *Heterodera major* Winslow | Stem & Bulb Eelworm | E. Beverley | August | 1958 |
| | Non Parasitic | Melanism | Nabawa | November | 1955 |
| | Non Parasitic | Frost Injury | Beverley | September | 1930 |
| | Non Parasitic | Excessive Transpiration | Nukarni | September | 1929 |
| *Briza maxima* L. (Blowfly Grass) | *Septoria sp.* | Leaf Spot | Cardup | October | 1923 |
| *Bromus Gussonii* Parl. (Ripgut Grass) | *Erysiphe graminis* DC. | Powdery Mildew | Nedlands | April | 1955 |
| | *Puccinia bromina* Eriks. | Brown Rust | Perth | October | 1923 |
| *Ceratochloa carthartica* (Vahl) Henr. (Prairie Grass) | *Ustilago bullata* Berk. | Head Smut | South-West | December | 1924 |
| *Chloris ruderalis* Domin (Star or Windmill Grass) | *Uromyces ? chloridis* Doidge | Rust | Carnarvon | | 1959 |
| *Cynodon dactylon* (L.) Pers. (Couch Grass) | *Agaricus spp.* | Fairy Rings | Metro. | | 1934 |
| | *Helminthosporium sp.* | Foot Rot | West Perth | June | 1925 |
| | *Helminthosporium sp.* | Seed Discolouration | Fremantle | August | 1955 |
| | *Marasmius oreades* (Bolt. ex Fr.) Fr. | Fairy Rings | Bridgetown | April | 1959 |
| | *Physarum cinereum* (Batch) Pers. | Slime Mould | Perth | | 1924 |
| | *Puccinia cynodontis* Desm. | Rust | Cottesloe | | 1937–38 |
| | *Rhizoctonia sp.* | Brown Patch | Metro. | | 1939 |
| | *Sclerotinia homeocarpa* F. T. Bennett | Dollar Spot | Nedlands | January | 1934 |

## Diseases Recorded on Cereals, Grasses and Pasture Legumes in Western Australia—continued

| Host | Cause | Common Name | FIRST RECORD | | |
|---|---|---|---|---|---|
| | | | Place | Month | Year |
| CEREALS AND GRASSES—*continued* | | | | | |
| *Cynodon dactylon* (L.) Pers. (Couch Grass)—*continued* | *Ustilago cynodontis* Henn. | Smut | Perth | April | 1923 |
| | *Helicotylenchus sp.* | Eelworm | Floreat Park | June | 1959 |
| | *Hemicycliophora sp.* | Eelworm | Floreat Park | June | 1959 |
| | *Nuytsia floribunda* R. Br | | | | 1918 |
| | Non Parasitic | Brown Patch<br>Water Stress and Heat Injury | Mosman Park | January | 1935 |
| *Cynodon transvaalensis* Burtt Davy. (Super Fine Couch Grass) | *Sclerotinia homeocarpa* F. T. Bennett | Dollar Spot | Metro. | January | 1957 |
| | Non Parasitic | Brown Patch<br>Water Stress and Heat Injury | Perth | January | 1935 |
| *Dactylis glomerata* L. (Cocksfoot) | *Claviceps purpurea* (Fr.) Tul. | Ergot | Coolup | January | 1954 |
| | *Puccinia graminis* Pers. | Stem Rust | Kelmscott | | 1956 |
| *Dactylis glomerata* L. (Currie Cocksfoot) | *Puccinia graminis* Pers. | Stem Rust | Wokalup | April | 1958 |
| *Dactylis glomerata* L. var. *maritima* (Neptune Cocksfoot) | *Puccinia graminis* Pers. | Stem Rust | Wokalup | November | 1954 |
| *Danthonia caespitosa* Gaud. (Ringed Wallaby Grass) | *Uromyces danthoniae* McAlp. | Rust | Pallinup River | November | 1958 |
| *Danthonia pilosa* R. Br. (Wallaby Grass) | *Ustilago comburens* Ludw. | Smut | Bridgetown | November | 1930 |
| *Danthonia semiannularis* (Labill.) R. Br. (Wallaby Grass) | *Helminthosporium sp.* | | Merredin | November | 1927 |
| *Echinochloa Crus-galli* (L.) Beauv. (Barnyard Millet or Japanese Millet) | *Ustilago crusgalli* Tr. et Earle | Head Smut | Wanneroo | March | 1922 |
| | Pathogen Not Recorded | Root Rot | Greenough | March | 1959 |
| *Ehrharta longiflora* Sm. (Annual Veldt Grass) | *Pleosphaeria semeniperda* Britt. et Adam | Pleosphaeria Blight | Carlisle | August | 1927 |
| | *Septoria sp.* | Leaf Spot | Lesmurdie Falls | August | 1923 |
| | *Anguina australis* Steiner | Leaf Gall | Crawley | October | 1926 |
| *Festuca elatior* L. (Tall Fescue) | *Claviceps purpurea* (Fr.) Tul. | Ergot | Nedlands | January | 1954 |
| *Festuca rubra* L. var. *commutata* Gaud. (Chewings Fescue) | *Helminthosporium sp.* | Brown Patch | Metro. | | 1935–36 |
| *Holcus lanatus* L. (Yorkshire Fog) | *Puccinia coronata* (Pers.) Cda. | Crown Rust | Osborne Park | | 1923 |
| *Hordeum hystrix* Roth. (Barley Grass) | *Ascochyta graminicola* Sacc. | Leaf Spot | Kondinin | March | 1925 |
| | *Puccinia graminis avenae* Eriks. et Henn. | Stem Rust | Kellerberrin | | 1943 |
| | ‡*Puccinia graminis tritici* Eriks. et Henn. | Stem Rust | Kellerberrin | | 1943 |
| *Hordeum leporinum* Link. (Barley Grass) | *Helminthosporium sativum* Pamm., King et Bakke. | Foot Rot | Merredin | November | 1931 |
| | *Mycosphaerella tulasnei* (Jancz.) Lindau | Black Mould | South Perth | November | 1923 |
| | *Ophiobolus graminis* Sacc. | Take All | | March | 1922 |
| | *Physarum cinereum* (Batch) Pers. | Slime Mould | Corrigin | June | 1958 |
| | *Phyllosticta sp.* | Leaf Spot | South Perth | November | 1923 |
| | *Pleosphaeria semeniperda* Britt. et Adam | Pleosphaeria Blight | Merredin | November | 1927 |
| | *Septoria passerinii* Sacc. | Leaf Spot | Nungarin | October | 1926 |
| | *Tilletia hordei* Koern. | Covered Smut | Merredin | | 1945 |
| | *Wojnowicia graminis* (McAlp.) Sacc. | Root Rot | Merredin | November | 1931 |
| | Non Parasitic | Frost Injury | Merredin | | 1931–32 |
| *Hordeum vulgare* L. (Barley) | *Alternaria sp.* | Black Mould | | December | 1959 |
| | *Coniothecium sp.* | Pink Stain | | | 1927–28 |
| | *Erysiphe graminis* DC. | Powdery Mildew | | | 1924 |
| | *Fusarium culmorum* (W. G. Sm.) Sacc. | Fusarium Foot Rot | Borden | February | 1959 |
| | *Helminthosporium gramineum* Rabh. | Stripe | | | 1924 |
| | *Helminthosporium sativum* Pamm., King et Bakke | Foot Rot | Woogenellup | October | 1959 |
| | *Mycosphaerella tulasnei* (Jancz.) Lindau. | Black Mould | | | 1924 |
| | *Ophiobolus graminis* Sacc. | Take All | Gnarming | November | 1927 |
| | **Puccinia graminis tritici* Eriks. et Henn. | Stem Rust | Northam | October | 1925 |
| | *Pyrenophora teres* (Died.) Drechsl. | Net Blotch | Mingenew | November | 1953 |
| | *Rhizoctonia solani* Kuhn | Foot and Root Rot | Gibson | December | 1959 |
| | *Rhynchosporium secalis* (Oud.) J. J. Davis | Scald | Lake Grace | October | 1926 |

* Races R. 126–1 and R. 222–5.
‡ Race R. 126–1.

## Diseases Recorded on Cereals, Grasses and Pasture Legumes in Western Australia—continued

| Host | Cause | Common Name | FIRST RECORD | | |
|---|---|---|---|---|---|
| | | | Place | Month | Year |
| CEREALS AND GRASSES—*continued* | | | | | |
| *Hordeum vulgare* L. (Barley)—*continued* | *Septoria passerinii* Sacc. | Leaf Blotch | Merredin | August | 1923 |
| | *Ustilago hordei* (Pers.) Lagerh. | Covered Smut | .... | .... | 1913 |
| | *Ustilago nuda* (Jens.) Rostr. | Loose Smut | .... | .... | 1913 |
| | Genetic | Variegated and Albino Seedlings | Newdegate | August | 1954 |
| | Non Parasitic | Frost Injury | Ongerup | November | 1953 |
| *Lolium multiflorum* Lam. (Italian Rye Grass) | *Puccinia coronata* (Pers.) Cda. | Crown Rust | Balcatta | July | 1949 |
| *Lolium perenne* L. (Perennial Rye Grass) | *Claviceps purpurea* (Fr.) Tul. | Ergot | Coolup | January | 1954 |
| | *Puccinia coronata* (Pers.) Cda. | Crown Rust | South Perth | November | 1925 |
| *Lolium rigidum* Gaud. (Wimmera Rye Grass) | *Claviceps purpurea* (Fr.) Tul. | Ergot | Kojonup | March | 1937 |
| | *Helminthosporium sp.* | Leaf Spot | Coolup | June | 1959 |
| | *Puccinia coronata* (Pers.) Cda. | Crown Rust | Mount Barker | September | 1959 |
| | *Septoria tritici* var. *lolicola* Sprague et Johnson | Leaf Spot | Geraldton | October | 1958 |
| *Lolium temulentum* L. (Darnel) | Non Parasitic | Frost Injury | Merredin | .... | 1931–32 |
| *Neurachne alopecuroides* R. Br. (Club Grass) | *Ustilago tepperi* Ludw. | Smut | Grass Valley | October | 1942 |
| *Oryza sativa* L. (Rice) | *Alternaria sp.*<br>*Aspergillus sp.*<br>*Cladosporium sp.*<br>*Helminthosporium sp.*<br>*Hormodendron sp.* | Complex Associated With Grain Discolouration | Uralla Creek | November | 1954 |
| | *Curvularia sp.* | Glume Discolouration | Uralla Creek | June | 1954 |
| | *Helminthosporium oryzae* Breda de Hann | Leaf Spot | †Ord River | March | 1957 |
| | *Nigrospora sp.* | Grain Spotting | Liveringa | July | 1954 |
| | *Trichoconis ? padwickii* Ganguly | Leaf Spot | †Ord River | May | 1957 |
| *Paspalum dilatatum* Poir. (Paspalum) | *Claviceps paspali* Stev. et Hall | Ergot | Harvey | .... | 1937–38 |
| *Pennisetum clandestinum* Hochst. ex Chiov. (Kikuyu Grass) | *Physarum cinereum* (Batch) Pers. | Slime Mould | Metro. | June | 1956 |
| *Phalaris tuberosa* L. (Toowoomba Canary Grass) | *Mycosphaerella tulasnei* (Jancz.) Lindau | Black Mould | Esperance | May | 1959 |
| | *Sclerospora macrospora* Sacc. | Downy Mildew | Esperance | May | 1959 |
| | Non Parasitic | Drought Injury, Tipping | .... | .... | 1959 |
| *Phalaris sp.* (Canary Grass) | Non Parasitic | Frost Injury | Merredin | .... | 1931–32 |
| *Poa annua* L. (Winter Grass) | *Puccinia poarum* Niels. | Rust | South Perth | November | 1923 |
| *Poa australis* R. Br. (Tussock Grass) | *Puccinia graminis* Pers. | Stem Rust | Pallinup River | October | 1957 |
| *Poa bulbosa* L. (Bulbous Blue Grass) | *Puccinia coronata* (Pers.) Cda. | Crown Rust | South Perth | November | 1927 |
| *Polypogon monospeliensis* (L.) Desf. (Beard Grass) | *Puccinia coronata* (Pers.) Cda. | Crown Rust | Gunyidi | October | 1956 |
| *Secale cereale* L. (Rye) | *Puccinia graminis secalis* Eriks. | Stem Rust | Merredin | December | 1924 |
| | *Puccinia recondita* Rob. ex Desm. | Leaf Rust | South Perth | October | 1959 |
| *Serrafalcus arenarius* (Labill.) C. A. Gardn. | *Puccinia bromina* Eriks. | Rust | Wongan Hills | .... | 1904 |
| | *Ustilago bullata* Berk. | Head Smut | Tammin | .... | 1910 |
| *Serrafalcus hordeaceus* (L.) Green et Godr. (Soft Brome Grass) | *Ustilago bullata* Berk. | Head Smut | Mount Barker | December | 1924 |
| *Sorghum sudanense* Stapf. (Sudan Grass) | *Pseudomonas syringae* V. Hall | Red Stain<br>Holcus Spot | Wonnerup | March | 1925 |
| *Sorghum vulgare* Pers. (Sorghum) | *Pseudomonas syringae* V. Hall | Red Stain<br>Holcus Spot | Harvey | March | 1929 |
| | *Macrophomina phaseoli* (Maub.) Ashby | Charcoal Rot | Ord River | March | 1949 |
| | *Pythium sp.* | Root Rot | Esperance | March | 1959 |
| | *Sphacelotheca sorghi* (Lk.) Clint. | Covered Smut | Armadale | April | 1953 |
| *Sorghum vulgare* Pers. var. *cafforum* (Thunb.) Hubb. et Rehder. (Kaffir Corn) | *Pseudomonas syringae* V. Hall | Red Stain<br>Holcus Spot | South Perth | February | 1926 |
| | *Sphacelotheca sorghi* (Lk.) Clint. | Covered Smut | Jardee | March | 1926 |

† Kimberley Research Station

## Diseases Recorded on Cereals, Grasses and Pasture Legumes in Western Australia—continued

| Host | Cuase | Common Name | FIRST RECORD | | |
|---|---|---|---|---|---|
| | | | Place | Month | Year |
| CEREALS AND GRASSES—*continued* | | | | | |
| *Sorghum vulgare* Pers. var. *saccharatum* (L.) Boerl. (Sweet Sorghum) | *Sphacelotheca sorghi* (Lk.) Clint. | Covered Smut | Wongong | May | 1928 |
| *Sorghum vulgare* var. *technicum* (Koern.) Jav. (Broom Millet) | *Pseudomonas syringae* V. Hall | Red Stain<br>Holcus Spot | Maylands | February | 1925 |
| | *Gibberella zeae* (Schw.) Petch | Stalk Rot | Dardanup | February | 1959 |
| | *Sphacelotheca sorghi* (Lk.) Clint. | Covered Smut | Yarloop | July | 1927 |
| *Stenotaphrum secundatum* (Walt.) Kuntze (Buffalo Grass) | *Helminthosporium sp.* | Brown Patch | Porongorups | May | 1959 |
| | *Lysurus sulcatus* (Cke. et Mass) Cunn. | Common Saprophyte in lawns | | | 1919 |
| | *Physarum cinereum* (Batch) Pers. | Slime Mould | Perth | March | 1925 |
| | *Piricularia oryzae* Cav. | Rice Blast | Mt. Lawley | January | 1958 |
| | *Sclerotinia homeocarpa* F. T. Bennett | Dollar Spot | Metro. | May | 1958 |
| | *Helicotylenchus multicincta* (Cobb) Golden | Eelworm | Metro. | April | 1958 |
| | *Hemicycliophora truncata* Colbran | Eelworm | Metro. | April | 1958 |
| | Non Parasitic | Water Stress<br>Heat Injury<br>Brown Patch | Metro. | February | 1955 |
| *Stipa variabilis* Hughes (Spear Grass) | *Ustilago hypodytes* (Schl.) Fr. | Smut | Merredin | November | 1951 |
| *Stipa spp.* (Spear Grasses) | *Puccinia flavescentis* McAlp. | Rust | | June | 1955 |
| | *Ustilago hypodytes* (Schl.) Fr. | Smut | Goomalling | November | 1925 |
| *Triticum vulgare* Vill. (Wheat) | *Corynebacterium tritici* (Hutch.) Burkh. | Bacterial Spike Blight | | | 1923 |
| | *Pseudomonas atrofaciens* (McCull.) Stapp | Basal Glume Rot | | | 1930–31 |
| | *Alternaria sp.* | Black Mould | Chapman | November | 1923 |
| | *Coniothecium sp.* | Pink Stain | | | |
| | *Curvularia ramosa* (Bainier) Boedijn | Foot and Root Rot | Moorine Rock | December | 1958 |
| | *Curvularia spicifera* (Bainier.) Boedijn | Foot and Root Rot | Wongan Hills | December | 1958 |
| | *Erysiphe graminis* DC. | Powdery Mildew | Perth | August | 1925 |
| | **Fusarium culmorum* (W. G. Sm.) Sacc. | Foot and Root Rot<br>Seedling Blight | Merredin | July | 1927 |
| | *Gibberella zeae* (Schw.) Petch | Foot Rot | Ongerup | January | 1957 |
| | *Helminthosporium sativum* Pamm., King, et Bakke | Foot and Root Rot | Bullfinch | October | 1926 |
| | *Helminthosporium ? tritici-vulgaris* Nisikado | Leaf Spot | Gutha | August | 1959 |
| | *Macrosporium sp.* | Black Mould | Yuna | December | 1922 |
| | *Mycosphaerella tulasnei* (Jancz.) Lindau | Black Mould | Dowerin | October | 1923 |
| | *Ophiobolus graminis* Sacc. | Take All | Quairading | February | 1924 |
| | *Penicillium sp.* | Black Mould | Walgoolan | April | 1925 |
| | *Physarum cinereum* (Batch) Pers. | Slime Mould | | June | 1958 |
| | *Pleosphaeria semeniperda* Britt. et Adam. | Pleosphaeria Seedling Blight | Merredin | July | 1927 |
| | †*Puccinia graminis tritici* Eriks et Henn. | Stem Rust | | | 1906 |
| | *Puccinia recondita* Rob. ex Desm. | Leaf Rust | | | 1906 |
| | *Pythium sp.* | Root Rot | Gnowangerup | December | 1958 |
| | *Rhizoctonia solani* Kühn | Foot and Root Rot | Gnowangerup | December | 1958 |
| | *Sclerospora macrospora* Sacc. | Downy Mildew | Three Springs | December | 1923 |
| | *Septoria nodorum* (Berk.) Berk. | Glume Blotch | Three Springs | August | 1926 |
| | *Septoria tritici* Rob. | Leaf Spot | Merredin | August | 1926 |
| | *Tilletia caries* (DC.) Tul. | Covered Smut | Perth | September | 1924 |
| | *Tilletia foetida* (Wallr.) Liro | Covered Smut | Merredin | September | 1925 |
| | *Urocystis tritici* Koern. | Flag Smut | | | 1921 |
| | *Ustilago tritici* (Pers.) Rostr. | Loose Smut | | | 1920 |
| | *Wojnowicia graminis* (McAlp.) Sacc. et Sacc. | Foot Rot | Quairading | February | 1924 |
| | *Anguina tritici* (Steinb.) Filipjev | Ear Cockle | | | 1900 |
| | *Ditylenchus dipsaci* Kuehn | Chlorotic Banding of Leaves<br>Stem Eelworm | Bodallin | September | 1946 |
| | ? Genetic | Pre-emergence Distortion | Beverley | July | 1958 |
| | Non Parasitic | Frost Injury<br>Whiteheads<br>Drought Injury | Mukinbudin | September | 1926 |
| | Non Parasitic | Dry Wind Injury<br>Whiteheads | Northern and Eastern Wheatbelt | | 1926 |
| | Non Parasitic | Malting in Fluffy Soils | Corrigin | August | 1926 |
| *Vulpia bromoides* (L.) S. F. Gray (Silver Grass) | *Ophiobolus graminis* Sacc. | Take All | | March | 1932 |
| *Zea mays* L. (Maize) | *Fusarium ? moniliforme* Sheld. | Kernel Rot | Bunbury | November | 1959 |
| | *Penicillium sp.* | Blue Eye | Carnarvon | July | 1956 |
| | *Puccinia sorghi* Schw. | Leaf Rust | | | 1918 |
| | Genetic | Tassel Seeds | Burekup | March | 1925 |
| | Non Parasitic | Branching of Cob | Belmont | March | 1930 |

* Identified August 1959 ; previously recorded as **Fusarium sp.**

† Races R. 126–1 and R. 222–5.

## Diseases Recorded on Cereals, Grasses and Pasture Legumes in Western Australia—continued

| Host | Cause | Common Name | FIRST RECORD | | |
|---|---|---|---|---|---|
| | | | Place | Month | Year |
| CEREALS AND GRASSES—*continued* | | | | | |
| Lawns and Turf (Various Grasses) | *Alternaria sp.* | Withering of Foliage | Gnowangerup | April | 1955 |
| | *Curvularia sp.* | Melting Out | .... | February | 1956 |
| | *Lysurus sulcatus* (Cke. et Mass) Cunn. | Common Saprophyte in Lawns | Metro. | May | 1957 |
| | *Marasmius oreades* (Bolt. ex Fr.) Fr. | Fairy Rings | .... | .... | 1932–33 |
| | *Physarum cinereum* (Batch) Pers. | Slime Mould | South Perth | May | 1956 |
| | *Rhizoctonia sp.* | Brown Patch | .... | .... | 1932–33 |
| | *Sclerotinia homoeocarpa* F. T. Bennet | Smothering of Grass | South Perth | February | 1956 |
| | *Thelephora terrestris* (Ehrh.) Fr. | Brown Patch | Floreat Park | July | 1957 |
| | Non Parasitic | Water Stress | Metro. | January | 1937 |
| | | Heat Injury | | | |

## APPENDIX

*Common Names and Botanical Equivalents.*

### LEGUMES

CLOVERS—
- Drooping Flowered—*Trifolium cernuum Brot.*
- Red—*Trifolium pratense* L.
- Strawberry—*Trifolium fragiferum* L.
- Subterranean—*Trifolium subterraneum* L.
- White—*Trifolium repens* L.
- Woolly—*Trifolium tomentosum* L.

KING ISLAND MELILOT—*Mellilotus indica* (L.) All.

LUPINS—
- N.Z. Blue—*Lupinus angustifolius* L.
- W.A. Blue—*Lupinus digitatus* Forsk.
- White—*Lupinus albus* L.
- Yellow—*Lupinus luteus* L.

LUCERNE—*Medicago sativa* L.

MEDICS—
- Barrel—*Medicago tribuloides* Desr.
- Burr—*Medicago denticulata* Willd.
- Snail's—*Medicago scutellata* Mill.

PEAS—
- Field—*Pisum arvense* L.
- Tangier—*Lathyrus tingitanus* L.

SNAIL'S CLOVER—*Medicago scutellata* Mill.

VETCH—*Vicia sativa* L.

### CEREALS AND GRASSES

BARLEY—*Hordeum vulgare* L.

BARLEY GRASS—*Hordeum leporinum* Link. *Hordeum hystrix* Roth.

BENT GRASS—*Agrostis stolonifera* L.

BEARDED WHEAT GRASS—*Agropyron scabrum* (Labill.) Beauv.

BEARD GRASS—*Polypogon monospeliensis* L. (Desf.)

BLOWFLY GRASS—*Briza maxima* L.

BROME GRASSES—
- Ripgut—*Bromus Gussonii* Parl.
- Soft—*Serrafalcus hordeaceus* (L.) Green et Godr.

BROWN TOP—*Agrostis tenuis* Sibth.

BUFFALO GRASS—*Stenotaphrum secundatum* (Walt.) Kuntze.

BULBOUS BLUE GRASS—*Poa bulbosa* L.

CANARY GRASS—*Phalaris* sp.

CANARY GRASS, TOOWOOMBA—*Phalaris tuberosa* L.

CLUB GRASS—*Neurachne alopecuroides* R. Br.

COCKSFOOT—*Dactylis glomerata* L.
- Currie—*Dactylis glomerata* L.
- Neptune—*Dactylis glomerata* L. var. *maritima.*

COUCH GRASSES—
- Common—*Cynodon dactylon* (L.) Pers.
- Super Fine—*Cynodon transvaalensis* Burtt Davy.

DARNEL—*Lolium temulentum* L.

FALSE OAT GRASS — *Arrhenatherum elatius* (L.) Mert. et Koch.

FESCUE—
- Chewings—*Festuca rubra* L. var. *commutata* Gaud.
- Tall—*Festuca elatior* L.

KAFFIR CORN—*Sorghum vulgare* Pers. var. *cafforum* (Thunb.) Hubb. et Rehder.

KIKUYU GRASS—*Pennisetum clandestinum* Hochst. ex Chiov.

MAIZE—*Zea mays* L.

MILLETS—
Barnyard—*Echinochloa Crus-galli* (L.) Beauv.
Broom—*Sorghum vulgare* var. *technicum* (Koern.) Jav.
Japanese—*Echinochloa Crus-galli* (L.) Beauv.

OATS—
Black—*Avena fatua* L.
Common—*Avena sativia* L.
Yatheroo—*Avena barbata* Brot.

PASPALUM—*Paspalum dilatatum* Poir.

PRAIRIE GRASS—*Ceratochloa carthartica* (Vahl) Henr.

REED—*Arundo* sp.

RICE—*Oryza sativa* L.

RIPGUT GRASS—*Bromus Gussonii* Parl.

RYE—*Secale cereale* L.

RYE GRASSES—
Italian—*Lolium multi-florum* Lam.
Perennial—*Lolium perenne* L.
Wimmera—*Lolium rigidum* Gaud.

SEA WHEAT—*Agropyron distichum* Beauv.

SILVER GRASS—*Vulpia bromoides* (L.) S. F. Gray.

SORGHUM—*Sorghum vulgare* Pers.

SORGHUM, SWEET—*Sorghum vulgare* Pers. var. *saccharatum* (L.) Boerl.

SPEAR GRASSES—*Stipa spp.*

STAR GRASS—*Chloris ruderalis* Domin.

SUDAN GRASS—*Sorghum sudanense* Stapf.

SWAMP WALLABY GRASS—*Amphibromus Neesii* Steud.

TUSSOCK GRASS—*Poa australis* R. Br.

VELDT GRASS, ANNUAL—*Ehrharta longiflora* Sm.

WALLABY GRASS—*Danthonia* spp.

WHEAT—*Triticum vulgare* Vill.

WHEAT GRASS, BEARDED—*Agropyron scabrum* (Labill.) Beauv.

WIND GRASS—*Aristida arenaria* Gaud.

WIND MILL GRASS—*Chloris ruderalis* Domin.

WINTER GRASS—*Poa annua* L.

YORKSHIRE FOG—*Holcus lanatus* L.

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Carne, W. M. (1925) J. Roy. Soc. W.A., XI, 7; 43-68.

——————— (1927) *Ibid* XIV, 3; 23-28.

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## A.B. SERVICE FEE CHANGES

The Minister for Agriculture (Mr. C. D. Nalder) has announced that he has approved recommendations of the Artificial Breeding Policy Committee including a variation of fees for service. Up to the present the basis was £2 per service with the right to a second and third if necessary. Should the cows not hold a further fee would be charged for the fourth with a right to the fifth and sixth and so on.

The Policy Committee has recommended that the basic fee of £2 per first insemination with a right to a second and third be continued but thereafter for all succeeding inseminations there be a flat rate of 15s.

Amongst other matters which have been considered by the Committee was the question of the service in the butterfat areas during the summer months. The experience over the last three years has indicated that it is extremely costly to maintain such a service and the Committee had recommended that this service should not be continued next year and that farmers should be advised of this decision now.

Mr. Nalder indicated that he was in agreement with this recommendation and therefore those few farmers who desire to mate cows during the period January 1 to May 31 should prepare to make other arrangements.

# CHEMICAL THINNING OF APPLES

By S. E. HARDISTY, B.Sc. (Agric.) and N. H. SHORTER

**TWO important related problems of apple-growing in this State are biennial bearing and poor fruit size. Early thinning by chemical means, is providing a valuable and practical means of tackling these problems. With every prospect of heavy crops in most districts this year, many growers will be interested in the possibility of spray thinning.**

The varieties Granny Smith, Delicious and Dunn's Seedling are well known for their biennial bearing habits and the recent cycle of abnormally dry seasons has shown that varieties such as Cleopatra, Jonathan and Yates also react in a similar manner under drought stress. Yates in any case are always inclined to set too heavily.

The accepted "on" year and "off" year type of production, which has become so pronounced in some varieties as the trees get older, must be regarded as uneconomic, particularly when whole districts may be affected this way, so that one year the packing houses are overtaxed and the next the plant remains idle.

In the heavy "on" year, inadequate thinning and dry summer conditions can accentuate the production of under-sized and sometimes unmarketable fruit, whilst at the same time the trees must also suffer. This reduces the overall production of the trees, as the heavy crop of small fruit is often followed by a very light crop of large fruit. The problem is accentuated by the fact that the main apple production comes from non-irrigated orchards. If the trees can be induced to carry a moderate crop of good sized fruit each year, the average annual yield, as well as the general quality will be greatly improved.

Poor fruit size brings some special problems. Several pickings are required, and often picking is commenced too early in order to relieve stressed overcropped trees, or on the other hand left too late waiting for the fruit to reach sufficient size. Growers are well aware of overseas reports of apples arriving in a too forward condition, and this can result from late picking. Minimum export sizes have been increased for certain destinations and the general trend is now away from the smaller sizes which also sell at a discount on the local market. Any satisfactory means of controlling cropping will lead to better and more even fruit size at harvest, so that instead of making several pickings, in order to get adequate size, the fruit may be picked closer to the correct stage of maturity, and also nearer to the optimum size requirement.

Hand thinning, carefully carried out, will help fruit size a lot, but is not sufficient to break the biennial bearing habit.

What is wanted is a means of easing the load on the trees as soon as possible after blossoming and this is where chemical thinning is of value.

## CHEMICAL THINNING

Scientific evidence has shown conclusively that thinning early, that is just after blossoming, by the use of chemical sprays helps very materially in breaking the biennial habit and at the same time in improving fruit size. Chemical thinning, however, should not be regarded as a complete substitute for hand thinning. It is merely the first step in crop control to encourage regular cropping and at the same time reduce the amount of handwork required. If extra hand thinning is not required, then some trees may have been overthinned.

By thinning early in the growing season, all the wasted effort of producing numerous

small apples which are eventually thinned off before maturity, is prevented. The trees' resources during the early active growing period are channelled towards developing marketable fruit. Also, by easing the burden at the critical stage, good fruit buds for the next year are initiated. Increased fruit size is not obtained at the expense of the crop, as little if any reduction in total yield has been noted.

Spray thinning can greatly reduce the laborious work of hand thinning in varieties such as Yates, but even for Granny Smiths, which are not normally extensively hand thinned a considerable size benefit can be expected. Better sized fruit will facilitate packing and increase output. However, the most valuable use of chemical thinning is in breaking biennial bearing.

A number of materials have been used for chemical thinning. Of those so far available in this State, naphthalene acetic acid or N.A.A. has been found to be the most suitable and the following discussion refers to this material.

Chemical thinning has been tried in this State for several years now, and some very useful results have been obtained both by Departmental officers and growers. Generally inconsistent results can be attributed to insufficient knowledge of the factors involved and especially reluctance in many cases to apply sufficient volume of spray.

The thinning of apple crops by chemical means has been accepted as routine practice in the U.S.A. and is widely used in other parts of Australia.

## SUCCESS WITH CHEMICAL THINNING

Some notable responses have been achieved on growers' properties. Perhaps the most outstanding success story is that of Mr. Dilley of Upper Capel, who has used chemical thinning on Granny Smiths, Yates, Golden Delicious and Delicious for several years. Production has risen from 5,000 bushels to 8,000 bushels and the tendency to biennial bearing has been largely overcome, thus giving good crops from year to year. Part of the improvement is due to irrigation.

The yearly average for the entire Granny Smith crop has been nine bushels a tree with season fluctuations of 7½ to 10 bushels. In the 1958-59 season, results with Yates also demonstrated the advantage of spray thinning, compared with normal hand thinning and gave a better crop in 1960.

In an unirrigated orchard at Bridgetown six even Granny Smith trees were sprayed with N.A.A. at late petal fall in the spring of 1958 and compared with six unsprayed trees. Forty-nine loose boxes were harvested from the six sprayed trees in one major picking compared to sixty loose boxes in four pickings from the unsprayed trees. In the 1959-60 season, despite a protracted and late blossoming with subsequent thrips infestation, 28 loose boxes were produced from the six trees previously sprayed with N.A.A. and none from the other six trees. The year 1959 was a drought season and the advantages of being able to pick a good crop of 2½ in. and over as compared with four pickings down to 2¼ in. on the unsprayed trees are obvious. As a result the late picked fruit was in a forward condition.

In another nine acre orchard at Bridgetown, previously stressed by several dry seasons and on a light soil, all trees showing good blossoming received a blanket spray of 10 ppm N.A.A. in 1959. The varieties included Delicious, Jonathan, Cleopatra, Dunn's Seedling, Yates and Granny Smith. Good thinning resulted on all varieties with some further hand thinning being required. The crop prospects are promising for the next season if the size of the fruit buds is any criterion. A point of interest during this season was the complete absence on this orchard of small irregular shaped fruit resulting from a late setting.

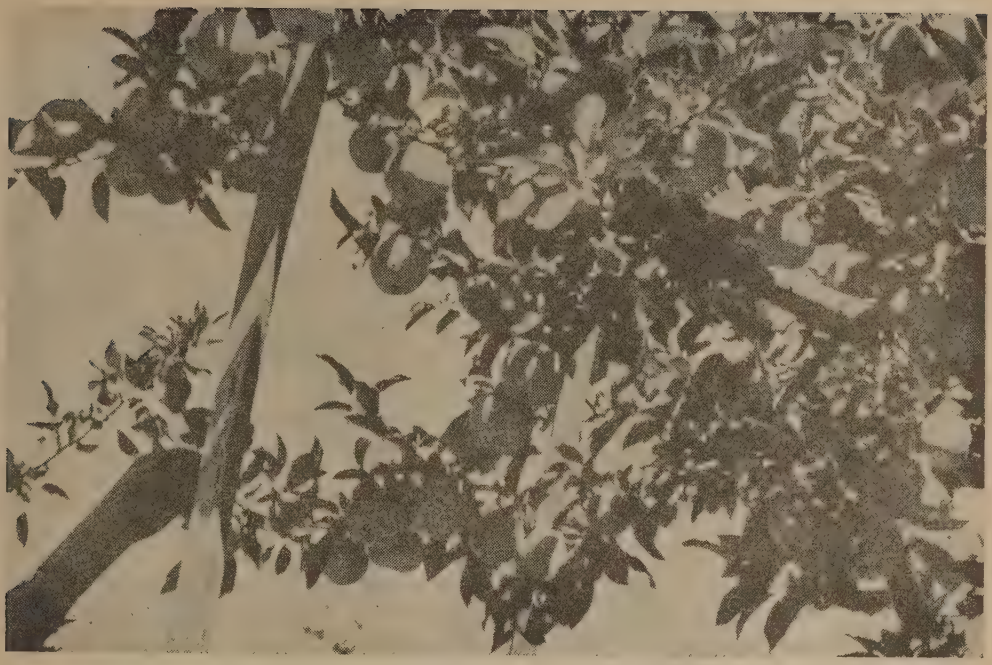
### Spraying Procedure.

Although each orchardist needs to work out the best procedure for his own particular conditions, the following points will provide a good working basis.

### Thoroughness of Spraying.

The thoroughness of spraying is very important and the poor results obtained by a few growers who have had difficulty with chemical thinning can be attributed to reluctance on their part to put on sufficient volume of spray.

Growers must be aware that if a tree is in its "on" year it is extremely difficult to prevent it from bearing a good to heavy crop. Where thinning sprays are used at the recommended strength, it is extremely



These good-sized and well-spaced Delicious apples are the result of chemical thinning

unlikely that too much fruit will be taken off in the "on" year and follow up hand thinning can still be expected.

A thorough spray of the upper two-thirds of a tree is generally essential. An average sized tree—if such a tree could be said to exist—would take 1 to 1½ gallons of spray. Large Yates trees can require as much as 2½ gallons of spray. Probably the best type of spray is a broad cone of fine droplets working at normal pressures. By concentrating on the upper two-thirds of the tree, it will be found that fruit spurs on the lower third of the tree are receiving a fair wetting from drift. In any case, this portion of the fruiting area, being more shaded, does not set as heavily and can be easily hand thinned. The tops of the leaders should receive special attention, as it is well known that fruit is hard to shift on the leaders, and this fruit always constitutes a hazard for limb breakages later in the season.

Varieties, which are hard to thin, are Yates and Doughertys and to a lesser extent Delicious, Golden Delicious and Jonathan and thorough spraying is necessary if a heavy setting is expected.

Granny Smith, in their heavy "on" year also come into this category, although where only a moderately heavy setting is anticipated or where trees are not so liable to biennial bearing, there would not be the same need for intensive thinning and a less complete spray may be advisable to prevent overthinning.

Growers have found in some cases, such as when young trees are coming into bearing or where a generally heavy crop is not expected, spraying only the tops of the leaders proves very effective in relieving the tops of the trees and minimising limb breakages.

**Type of Machine.**

Conventional spraying units at normal pressures (250-300 lb. per square inch) are preferred to concentrate or air blast machines. However, these latter machines have been used by blocking off the lower two jets of the assembly and by mixing three times (3X) the recommended

strength. In one instance, a commercial application of 45 ppm N.A.A. gave excellent thinning results on Yates. Some overseas workers maintain that twice (or 2X) normal strength should not be exceeded. The question of having to give individual trees special attention poses a distinct problem, when air blast machines are used.

**Time of Application.**

This again is an important factor and for consistent results the right time is at late petal fall. There is some latitude, but growers should strive to spray as near as possible to this period, treating varieties separately as they reach the optimal stage. Earlier sprays near full bloom and later sprays from the calyx stage onwards, may give inconsistent results.

**Strength of N.A.A. for Chemical Thinning.**

The strength of N.A.A. to be applied to varieties such as Granny Smith, Jonathans, Cleos and Dunns is 10 ppm without additives. Commercial preparations of N.A.A. for pre-harvest drop of apples, when mixed accordingly to the maker's directions are designed to give a final mixture of 10 ppm in the spray vat.

The addition of white oil or other spreaders to the mixture will increase the thinning action. Therefore, unless specifically recommended, they should be avoided. All proprietary brands of pre-harvest drop N.A.A. already contain a wetting agent and therefore effectively wet the leaves.

Some varieties set heavily and are hard to budge. With strong blossoming varieties, such as Yates and Doughertys, 10 ppm is not sufficient and 15 ppm (1½ times normal strength) is needed. The addition of 2 to 3 pints of white oil may still be necessary for best results.

Red Delicious and Golden Delicious have been very effectively thinned with 10 ppm N.A.A. with the addition of 2 pints of white oil.

## COMMERCIAL PREPARATIONS

Stop drop preparations, such as "Phyomone" and "Shellestone" which contain N.A.A. can be used. However, at least two preparations, which are also used as stop drop sprays, namely "Stayput A" and "Promone" contain 2,4,5-T.P. as the active ingredient and they must never be used for chemical thinning of apples.

## COMBINED THINNING AND INSECTICIDAL SPRAYS

Although it is possible to mix N.A.A. with certain insecticidal sprays, this practice is not generally recommended as the coverage required will usually be different for each purpose.

## A NORMAL BLOSSOMING PERIOD IS HELPFUL

Irregular and protracted blossoming was a feature of the 1959-60 season following the very mild winter experienced. Where the blossoming period is definite with all flowers on a tree opening over a short interval of time, the grower is in a better position to successfully chemically thin. Oil sprays applied during the first half of August and more particularly the winter oil spray containing di-nitro-cresol (D.N.C.) will induce better blossoming, especially in those districts which regularly suffer from delayed foliation effects.

Apple trees on their "off" year come into blossom more irregularly and later than "on" year trees in the same orchard. Trees which have been chemically thinned during the "on" year, still behave in this manner and would greatly benefit from a D.N.C.-oil spray, during August in the same way.

## CLEOPATRAS

Some growers may be hesitant to spray thin Cleos, having regard to the large fruit—more pit complex usually encountered with this variety. However, as the thinning effect only reduces the numbers of apples per spur and rarely eliminates all the fruit from a spur, it has been found that the incidence of pit has not been increased with the possibility of a significant decrease in this disease.

## PRUNING TRENDS EXPECTED WITH THINNING

With mature apple trees, pruning practices are aimed at thinning out fruiting spurs to induce greater vigour and replenish fruiting wood. Old trees, being spray thinned have little pruning requirement as cropping is largely controlled and lateral vigour is thereby increased. This has been amply illustrated in several old orchards. Thinning out of crowded limbs might be necessary at a later stage.

**AVAILABLE SOURCES OF N.A.A.**

Phyomone—I.C.I. (A.N.Z.). Available from most local agents.

Shellestone—Shell Chemicals. Available from most local agents.

These preparations should be mixed for spray thinning at the same concentration (i.e., 10 ppm) as for pre-harvest drop prevention, except for Yates and Doughertys which require 15 ppm or one and a half times normal concentration.

**SUMMARY**

(1) From experience gained over several years of trial work carried out in conjunction with growers it is considered that N.A.A. is the best material to use at present.

(2) For biennial bearing varieties commence spraying when the trees are in their "on" year.

(3) Spray when 80 to 90 per cent. of the petals have fallen, or when most of the petals will fall off when sprayed.

(4) Treat each variety and each tree separately according to its requirements, i.e., strength of blossoming and variety.

(5) For Granny Smith—

(a) For "on" year trees expected to set a heavy crop and especially if trees are not irrigated use a thorough spray of 10 ppm.

(b) For trees expected to set a moderately heavy crop and not irrigated or a heavier crop under favourable conditions, thoroughly spray the upper third of the trees with 10 ppm.

(c) Where little thinning is required spray only the tops of the leaders with 10 ppm. The main purpose would be to reduce limb breakage. This type of spraying would apply to young trees or trees with moderate crops.

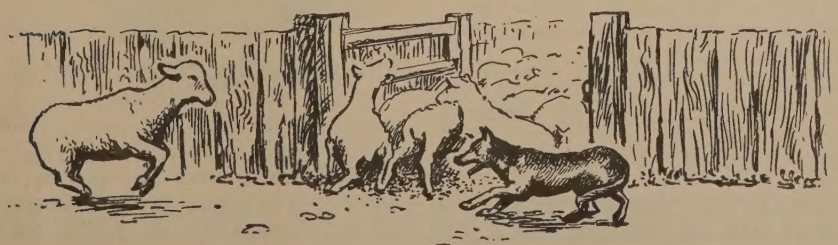
(6) For Jonathan, Golden Delicious, Delicious, Cleos and Dunns use a thorough spray of 10 ppm concentrating on the upper two-thirds of the tree. For Golden Delicious and Delicious the addition of white oil has given very good results.

(7) For Yates and Doughertys use a thorough spray of 15 ppm concentrating on the upper two-thirds of the tree. The addition of 2 to 4 pints of white oil per 100 gallons has given good results.

(8) Complete the thinning by hand in late November or December.

**IN CONCLUSION**

There is with many growers a difference when approaching chemical thinning for the first time for fear that too many fruits will be removed. However, at the above recommended strengths and with thorough spraying, subsequent hand thinning can still be expected. It is well-nigh impossible to prevent good setting on an "on" year cropping apple tree. Many growers spray thinned this year; some who sprayed lightly have had moderate success, others by first indications considered that they had overthinned by thorough spraying, and now admit to picking one of their best crops. The grower should know his own trees better than anyone else and be in the best position to assess the need for chemical thinning and also the value of uniform cropping. Once he has come to the realisation that chemical thinning pays, he will find that both his trees and his returns will benefit.



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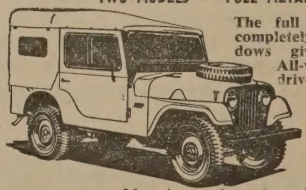

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# *Some Results* WITH NITROGEN FERTILISER ON CEREALS AT ESPERANCE PLAIN RESEARCH STATION

By W. J. TOMS, B.Sc. (Agric.), Research Officer, Plant Research Division

**ON newly-cleared land at Esperance Plain Research Station the use of sulphate of ammonia on cereals has proved profitable over a number of seasons. The response to sulphate of ammonia varies markedly with the season.**

The yield of cereals on newly-cleared land on the Esperance Plain Research Station has varied markedly depending on the season. In the first few years of development at the Station very low crop yields were obtained (Shier and Dunne unpublished data) and it could only be concluded that cropping new land in this area was not economical. Results of later variety trials (Shier and Reeves 1954, 1957, Wild and Reeves 1956, 1957, and Reeves 1954) and results of fertiliser experiments (Dunne and Shier unpublished data) indicate that on the average, profitable cereal crops can be grown on many soils of the Esperance Plain. (However, no results are available for the deep sandy soils of the area.)

For example, over a seven-year period on newly-cleared land, an average wheat yield of about 11 bushels per acre has been obtained. Over five years there was an average of 13 bushels per acre of barley and over four years an average of 17 bushels per acre of oats.

## 1959 RESULTS WITH SULPHATE OF AMMONIA

In 1959, two experiments with sulphate of ammonia on cereals were planted. One of these tested the effect of sulphate of ammonia on barley planted on newly-cleared well-fallowed land.

The results of this experiment are listed in Table 1.

Table 1

EFFECT OF RATES OF SULPHATE OF AMMONIA ON GRAIN YIELD OF BARLEY ON "NEW" LAND—ESPERANCE PLAINS RESEARCH STATION, 1959

| Treatment | Sulphate of Ammonia (lb./acre) | Yield (bushels/acre) |
|---|---|---|
| 1 | *Nil* .... .... .... .... .... .... | 19 |
| 2 | 28—Drilled with Seed .... .... .... | 25 |
| 3 | 56— Do. do. .... .... .... | 32 |
| 4 | 112—½ drilled with seed, ½ broadcast prior to seeding .... .... .... | 39 |
| 5 | 224— Do. do. do. | 44 |
| 6 | 448— Do. do. do. | 47 |
| 7 | 448—Broadcast prior to seeding .... | 51 |
| 8 | 224—½ drilled with seed, ½ broadcast prior to seeding .... .... .... } 224—Broadcast in August .... .... } | 53 |

Super 150 + copper ore 30 + zinc oxide 3 (lb. per acre) were applied to all plots.
This fertilizer was mixed with the sulphate of ammonia for all treatments except Treatment 7.

Large increases in yields were obtained even with very low rates of sulphate of ammonia. Two cwt. of sulphate of ammonia applied at seeding was insufficient for maximum yields. (cf. yields from Treatments 5 and 8.)

The second experiment planted in 1959 was on land that had been under subterranean clover (Bacchus Marsh) for six years. As this experiment was designed for other purposes, only one rate of sulphate of ammonia was used.

The response to this dressing of sulphate of ammonia was surprisingly great considering the good yield obtained without nitrogen fertiliser (Table 2.)

Table 2

EFFECT OF SULPHATE OF AMMONIA ON GRAIN YIELD OF WHEAT SOWN AFTER SIX YEARS OF CLOVER LEY—ESPERANCE PLAIN RESEARCH STATION, 1959

| | Yield (bushels/acre) |
|---|---|
| Without sulphate of ammonia .... .... .... | 35 |
| With 112 lb. per acre of sulphate of ammonia .... | 46 |

Although the ley period has lifted the yield of wheat far above that expected from "new" land, it is evident that in suitable seasons lack of nitrogen still limits crop growth even on old clover land.

## CONCLUSIONS FROM EXPERIMENTS

From these two experiments it should not be concluded that large and economical responses would always be obtained from using sulphate of ammonia on cereals in the Esperance district.

The response to sulphate of ammonia varies greatly with the season. Response tends to be greater in years when good yields are obtained from crops without the use of nitrogen fertiliser. (Dunne and Shier unpublished data). Use of nitrogen fertiliser cannot therefore be regarded as a complete insurance against a poor crop. However results indicate that the use of sulphate of ammonia at a rate of between 56 and 112 lb. per acre over a number of years would be profitable on cereals grown on newly-cleared land.

Application of the sulphate of ammonia at seeding and mixed with superphosphate has been found satisfactory in this area when applying between 56 and 112 lb. per acre of sulphate of ammonia.


## ACKNOWLEDGMENT

All of the experiments mentioned in this article were planted and harvested by Mr. E. B. Norris and other staff of the Esperance Plain Research Station.


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## LICE ON SHEEP

There had been a slight increase in the number of lice-infested sheep detected at the metropolitan sales, said the Minister for Agriculture (Mr. C. D. Nalder), recently.

There were 1,376 lice-infested sheep among a total of 244,778 inspected at Midland Junction sales, but 130,300 sheep inspected at country sales appeared to be free of vermin.

While this incidence is still reasonably low it emphasises the need for more careful attention to dipping after shearing.

Little evidence of vermin infestation in agricultural clips was revealed by inspection of wool on the show floors, but a considerable number of pastoral clips were affected by lice.

Because of the effects of drought and the difficulties encountered in obtaining clean musters, dipping cannot be enforced in the pastoral areas and is not compulsory as it is in agricultural districts.

In their own interests however, pastoralists would be well advised to dip their flocks off shears as an annual routine where seasonal conditions permit.